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SUMMARY OF EPA ENERGY POLICY ANALYSIS

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SUMMARY OF EPA
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By

ICF, Incorporated

Environmental Protection Agency
Review Notice

This report is under review by the Environmental Protection Agency. The views, policies, and recommendations in this report are those of the authors alone. The Environmental Protection Agency has not reviewed or approved the findings contained in this study.

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William C. Stitt　　　　Donald G. Ogilvie

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I. EXECUTIVE SUMMARY

Nature of the Energy-Environmental Problem

The "energy crisis" and its relation to the environment has two parts:

- National Energy Consumption and Supply Problem --- the U. S. energy crisis exists only within the framework of national energy objectives. Current U. S. economic, public welfare, and environmental policies define a set of future supply and consumption requirements which do not "balance." The national energy problem is to determine the best way to modify existing policy objectives to balance future energy supply and consumption.

- National Energy-Environmental Problem --- EPA must ensure that environmental protection is given equal consideration, relative to other national objectives, in policy decisions required to match future energy consumption and the amount, mix, and form of energy supply.

1. RECENT TRENDS INDICATE THAT THE U. S. IS BEGINNING A BASIC TURNAROUND IN ITS ENERGY POSITION.

Through its history, the U. S. has had generous supplies of low-cost energy raw materials available from its domestic resource base. This situation, however, may not continue in the future as indicated by: recent growth of energy consumption at a rate faster than GNP growth rate; the failure of proved reserves of oil and natural gas to increase proportionately with consumption; a decline in the thermal efficiency of electricity conversion; increased concern with protecting the natural environment; and doubts that nuclear energy will be available at costs as low as originally expected.

2. THE ENERGY MARKETPLACE IS AFFECTED BY GOVERNMENT ECONOMIC AND PUBLIC WELFARE POLICY AS WELL AS GROWING ENVIRONMENTAL CONCERNS.

Government policies affect virtually every aspect of energy consumption and supply. Specifically Federal, state, and local government actions and regulatory policies affect the energy marketplace through price level, price structure, tax policy, import policy, and public land management.

Environmental policy affects energy consumption in five major ways: by reducing the flexibility in the composition of total energy supply; by increasing the consumption and supply imbalances for clean fuels (oil and natural gas); by using additional energy to protect the environment; and adding a new set of considerations and extra uncertainty to energy decision-making at all levels.

3. THE "CLEAN FUELS" DEFICIT IS THE MOST IMMEDIATELY PRESSING ENERGY-ENVIRONMENTAL PROBLEM.

State Air Implementation Plans for sulfur oxide control under the Clean Air Act of 1970 reduce the flexibility of fuel supply available for stationary sources and produce a deficit of environmentally - acceptable clean fuel. In addition, adequate response to SIP's will increase energy consumption, introduce considerable uncertainty, and require a significant change in the status quo.

- Depending on the course of the response to the clean fuel problem, total 1975 oil imports could rise by 13-45 percent.
- Projected increases in petroleum imports might be offset by rapid development of low-sulfur coal and stack gas cleaning technology.
- However, the prospects for both increased low-sulfur coal and stack gas cleaning are uncertain and not subject to EPA control.
- Nevertheless, unless progress is made rapidly on the development of stack gas cleaning and low sulfur coal, the clean fuels deficit could become a long-run EPA problem.

4. AUTO EMISSION CONTROL IS GENERALLY CONSIDERED TO BE A COMPLICATING FACTOR IN THE "CLEAN FUEL" DEFICIT.

If nothing else changes, currently - planned auto emission control standards will increase total fuel usage 7-10 percent by 1980. However, many factors other than emission controls affect fuel consumption. The lack of reliable evidence about how these factors will change in response to higher fuel costs and increased auto price make it impossible to accurately predict the ultimate impact of emission controls on the clean fuels deficit.

5. THE CONFLICT BETWEEN ENVIRONMENTAL AND ENERGY OBJECTIVES RAISES SEVERAL OTHER KEY PROBLEMS.

Although the clean fuel shortage and auto emission standards are pressing energy-environmental problems, a variety of other key problems include:

- Energy facility siting policies
- Mineral extraction regulation
- Water resource creation and use
- Energy conservation.

U. S. Energy Consumption and Supply Outlook

1. TOTAL U. S. ENERGY CONSUMPTION IS FORECAST TO INCREASE 60-90 PERCENT DURING THE 15-YEAR PERIOD FROM 1970-1985.

Table 1 on the following page shows eight different estimates of total U. S. energy consumption through 1985. Based on these estimates, energy consumption will increase from 70 quadrillion BTU's in 1970 to 110-130 quadrillion BTU's by 1985.

TABLE 1: ESTIMATED U. S. ENERGY CONSUMPTION
(Quadrillion BTU's)

Source of Estimate	Actual	Estimated		
	1970	1975	1980	1985
National Petroleum Council				
• Low	68	80	96	113
• Intermediate	68	85	103	125
• High	68	87	105	130
Department of Interior	68	80	96	117
Environmental Protection Agency				
• Baseline Study	68	88	108	132
• Energy Conservation Study	68	83	102	120
Oil and Gas Journal	68	83	102	NA
Lawrence Livermore Labs	68	NA	NA	122

Source: ICF, Incorporated. Individual estimates prepared by each organization as indicated.

Forecast of U. S. energy consumption varies over a wide range because all energy estimates are sensitive to a number of key assumptions; extended to the year 2000, the differences between the high and low forecasts could equal the total amount of energy consumed in 1970. The effect of price changes on energy consumption and supply is uncertain. Although some forecasts consider price effects, these uncertainties make the validity of all forecasts subject to question.

2. THE PROPORTION OF TOTAL ENERGY CONSUMPTION ACCOUNTED FOR BY EACH ENERGY-USE SECTOR CHANGED LITTLE DURING THE LAST 20 YEARS. NO MAJOR CHANGES BETWEEN SECTORS ARE FORECAST THROUGH 1985.

- Energy consumption by ultimate consumer sector (residential/ commercial, industrial, transportation) has remained remarkably constant since 1950.

- The rapid growth in electrical consumption has shifted the use of primary energy from final users to electrical generators. This shift is expected to continue.

- There have been and will continue to be major shifts in the relative importance of alternative types of fuels; conventional oil and gas will continue to account for over two-thirds of the total; coal's share of the total will decline; and nuclear energy will increase.

- Even under optimistic assumptions, the effect of new energy sources on total energy consumption will be small until after 1985; energy from synthetic products of oil shale, coal, and nuclear stimulation will account for less than 6 percent of the total by 1985; energy from new technology (breeder reactors, and solar power) will make a negligible contribution to U. S. energy requirements before 1985.

3. IMPORTED ENERGY WILL ACCOUNT FOR AN EVER INCREASING SHARE OF U. S. ENERGY CONSUMPTION THROUGH AT LEAST 1980. IMPORTS AS A PERCENT OF THE TOTAL MAY DECLINE THEREAFTER IF A MAJOR DOMESTIC PRODUCTION PROGRAM IS UNDERTAKEN IMMEDIATELY. IMPORTS WILL BE THE SWING ITEM IN MATCHING U. S. CONSUMPTION AND DOMESTIC PRODUCTION.

Imports of petroleum and gas accounted for 12 percent of U. S. consumption in 1970 (8.4 quadrillion BTU's). Imports are forecast to increase to a possible high of 30-40 percent by 1980, depending on consumption and supply forecast. The share of U. S. energy supplied by imports may peak in 1980 and then decline if a major domestic energy production program is initiated within the next few years.

Key Energy Proposals

1. THERE ARE SEVEN BASIC CATEGORIES OF POLICY PROPOSALS TO CLOSE THE GAP BETWEEN FORECAST ENERGY REQUIREMENTS AND ENERGY SUPPLY.

- Maintain domestic supplies and meet increased demand by importing petroleum and natural gas.
- Meet increased demand by increasing domestic supplies of petroleum and natural gas.
- Decrease petroleum and natural gas demand by converting more coal and nuclear resources to electric power.
- Increase domestic supplies by converting other domestic fossil fuels to petroleum and natural gas.
- Produce the impact of environmental protection on energy consumption and supply.
- Decrease domestic consumption of energy.
- Increase domestic supplies by developing technology capable of tapping unconventional energy resources.

Table 2 on the following page summarizes current energy policy proposals and indicates the approximate time period during which their impact on energy consumption and supply becomes significant.

2. THE CURRENT ENERGY PROPOSALS SIGNIFICANTLY IMPACT ENERGY CONSUMPTION AND SUPPLY AT WIDELY VARYING POINTS IN TIME OVER THE NEXT 20 YEARS.

- Few of the proposals could be effective before 1980.

TABLE 2: KEY FEDERAL ENERGY PROPOSALS

	Time Period When Proposals Begin To Significantly Impact Energy Consumption and Supply		
	1973-1979	1980-1985	1985-2000
I. IMPORT PETROLEUM AND NATURAL GAS			
• Expand Petroleum Import Quotas	X		
• Stimulate Greater Domestic Resid Refining Capacity Through "Bonus Tickets"	X		
• Construct Superports	X		
• Stimulate LNG Imports Through New Trade Agreements	X		
• Increase Canadian Natural Gas Imports	X		
II. INCREASE DOMESTIC PETROLEUM AND NATURAL GAS PRODUCTION			
• Accelerate Offshore Leasing Programs		X	
• Deregulate Interstate Natural Gas Prices		X	
• Employ Nuclear Devices to Fracture Tight Natural Gas Sands			X
III. DECREASE PETROLEUM AND NATURAL GAS DEMAND BY CONVERTING MORE COAL AND NUCLEAR RESOURCES TO ELECTRICITY			
• Develop Low-sulfur Coal Resources, Particularly Western Coal	X		
• Physically and Chemically Desulfurize High-sulfur Coal		X	
• Clean High-sulfur Stack Gases	X		
• Accelerate Licensing of Nuclear Plants		X	
• Develop Fast Breeder Reactor Technology			X
IV. CONVERT OTHER DOMESTIC FOSSIL FUEL MINERALS TO PETROLEUM AND NATURAL GAS			
• Convert Coal to Synthetic Petroleum and Gas			X
• Bring Oil Shale to the Point of Commercial Feasibility			X
V. MODERATE IMPACTS OF ENVIRONMENTAL PROTECTION ON ENERGY CONSUMPTION AND SUPPLY			
• Modify the State Implementation Plans for Air	X		
• Modify regulations for: Mobil Source Emissions, Strip Mining, Offshore Drilling and Plant Siting		X	
VI. DECREASE DOMESTIC CONSUMPTION OF ENERGY RESOURCES			
• Increase Gasoline Prices Through Higher Excise Taxes		X	
• Initiate a Voluntary Consumer-Use Conservation Program		X	
• Improve Extraction, Conversion, and Distribution System Efficiencies		X	
VII. DEVELOP TECHNOLOGY TO TAP UNCONVENTIONAL ENERGY RESOURCES			
• Support Development of "Exotic Sources"			X

- Proposals that convert oil shale into synthetic petroleum and gas will provide no significant relief before 1980.
- Proposals to develop new high-technology energy systems (such as breeder reactors) will not provide significant energy inputs until after 1990.

3. THE CURRENT ENERGY PROPOSALS HAVE A WIDELY VARYING POTENTIAL FOR ADVERSE ENVIRONMENTAL IMPACT.

Although all energy systems pollute, their environmental effects vary widely. First, because their impacts on total energy consumption and supply begin at different times, the potential environmental implications of alternative energy systems becomes significant at different points in the future. Second, alternative systems differ environmentally in two principal ways:

- The specific pollutants produced (sulfur vs. radiation).
- The media into which pollutants are introduced (sulfur oxide and air vs. sulfur acid and water).

Macro-Environment Implications of Energy Growth

U. S. energy consumption will almost double between 1970 and 1985. The environmental damage resulting from this growth will depend on the fuels extraction and refining processes, transportation methods, and environmental protection measures involved. Nevertheless, even if every precaution is taken, a doubling of U. S. energy consumption in a fifteen-year period could have potentially dramatic environmental effects.

Section V illustrates the effect of energy consumption growth on the environment during the next fifteen years. The environmental implications are based on reasonably pessimistic (from an environmental standpoint) energy supply assumptions: supply is developed domestically whenever feasible; environmental standards are not dramatically increased; imports will be minimized; and energy consumption will double during the next fifteen years.

1. **BY 1985, A MAXIMUM DOMESTIC OIL DEVELOPMENT PROGRAM WILL REQUIRE MAJOR INCREASES IN EXPLORATION, DRILLING, AND EXTRACTION. MUCH OF THIS ACTIVITY WILL OCCUR IN AREAS WHICH ARE MORE PRONE TO ENVIRONMENTAL DAMAGE THAN EXISTING OIL-PRODUCING AREAS.**

The number of oil wells drilled annually will double by 1985, the average depth will increase 10-12 percent, offshore leasing will more than triple, and exploratory drilling will shift significantly to environmentally sensitive offshore and Alaskan areas. As domestic petroleum production increases, there will be a corresponding growth in oil pipelines and land consumed by distribution facilities. Domestic refinery capacity will increase about 80 percent to process the increase supply of domestic and imported crude petroleum.

2. **A MAXIMUM DOMESTIC NATURAL GAS DEVELOPMENT PROGRAM WILL REQUIRE EXTENSIVE INCREASES IN EXPLORATORY DRILLING AND PRODUCTION.**

The number of natural gas wells drilled will double by 1985 and the average depth will increase almost 30 percent. Natural gas drilling will also shift towards more environmentally sensitive offshore activities, although the magnitude of the change and the potential environmental damage will be less than for oil production. Nuclear explosive stimulation will be used to generate natural gas reserves, and gas pipelines will be constructed to collect and distribute increased gas production.

3. **ELECTRICAL GENERATING CAPACITY IS FORECAST TO QUADRUPLE DURING THE NEXT TWENTY YEARS.**

As both the supplier and consumer of energy, the electrical utility sector will play a major role in the energy balance, and its environmental effects will be far reaching. Many key environmental issues -- such as power plant siting, nuclear radiation, thermal water discharge, and sulfur emission from coal burning plants -- will be dominated by the scope and magnitude of electrical generation.

Nuclear plants may account for over 40 percent of new generating capacity. By 1990, over 400 nuclear plants are expected, most constructed after 1970.

Land required for increased electricity production and distribution will be sizeable. In addition, the use of water for cooling will increase appreciably.

4. IN SPITE OF ENVIRONMENTAL AND FINANCIAL CONSTRAINTS, THE PRODUCTION OF U. S. COAL IS EXPECTED TO DOUBLE BY 1985.

As coal production grows, there will be a major shift towards increased surface mining, the environmental effects of which may be dramatic. The potential environmental implications of increased coal production raise serious questions about the need for increased surface and deep mining regulation.

Energy-Environmental Conclusion and Next Steps

Among the many conclusions and issues associated with the initial EPA analyses of the energy environmental problem, a few are of overriding importance. Almost all stem from one fact:

1. ENERGY CONSUMPTION AND ITS POTENTIAL IMPACT ON THE ENVIRONMENT IS GOING TO INCREASE RAPIDLY THROUGH 1985, AND POSSIBLY BEYOND.

Despite advances in environmental protection hardware and governmental legal and enforcement efforts, a 3.5 to 4.5 percent energy consumption growth rate probably would increase the overall impact of energy production and consumption on the environment. If primarily domestic resources are used to support this growth, environmental damage might increase faster than the energy growth rate itself, primarily because our most abundant fossil fuel resources (principally coal) embody the greatest environmental damage. Of course, during the next fifteen years the amount and timing of damage related to greater exploitation of coal depends on the success in finding new petroleum and natural gas fields domestically.

Any shortfall in petroleum and gas will accelerate coal conversion to gas and petroleum synthetics. This substitutability of energy resources (illustrated by coal versus conventional petroleum and gas) -- which is enhanced by new technology to produce various fuel forms from different fuel minerals -- has two bearings on the energy-environmental problem. First, it increases the flexibility of energy systems to shift environmental impacts to different physical forms and/or physical locations. This can mean that the outcome of any unavoidable or discretionary choice between conventional petroleum and natural gas or coal can embody large tradeoffs between water, air and land pollution and environmental degradation in different regions. Conversely, this flexibility means that the environmental effects of increased energy use -- and increased usage of coal -- may be capable of substantial moderation through prudent choice of sites for energy using and energy producing activities.

Secondly, however, this substitutability and flexibility increases the problem, on the one hand, of optimizing the energy-environmental problem and, on the other, of affecting any optimum solution through direct or indirect government action. At the moment nobody is adequately prepared to either make or affect an optimum solution to the energy-environmental problem.

Given this analytical difficulty, current energy policymaking is complicated and the risks of "crisis-oriented" decision-making increase. Unfortunately, any urgency (particularly beyond the shortrun, transitional problem of a clean fuel deficit) is highly sensitive to small changes in future consumption and supply forecasts. Specifically, much of the pressure for crisis decision-making is based on forecasts of uncertain quality.

7. FURTHER EPA ANALYSIS OF THE ENERGY-ENVIRONMENTAL PROBLEM SHOULD CONCENTRATE ON MINIMIZING THE ADVERSE ENVIRONMENTAL IMPACTS OF AN ENERGY STRATEGY AIMED AT DOMESTIC SELF-SUFFICIENCY.

Future EPA analysis of the energy problem should meet one or both of two criteria:

- An attempt to anticipate and mitigate the adverse environmental implications of greater exploitation of domestic energy resources.
- Improvement of EPA's knowledge of the fundamental assumptions driving that strategy.

According to these criteria, six analytical areas appear most important:

Clean Fuels Deficit -- two aspects of this critical problem need further attention; SIP modifications and other steps required to relieve the clean fuels deficit during and after 1975. Of critical importance is the placing of orders for stack gas cleaning equipment and long-term contracts and/or new low-sulfur coal mine openings.

Mining Regulation -- since self-sufficiency portends greater coal usage, adequately protecting the environment from mining activity is vital.

Facility Siting -- electric power plant and superport/refinery siting can dramatically affect both energy supplies and the environment; particularly given the long planning and construction lead times involved; policymaking delays now have affect many years into the future.

Energy Supply and Consumption Forecasts -- the energy "crisis" is to a large extent a function of forecasts; consequently, their validity needs confirmation.

Energy Conservation -- due to the potential savings and environmental benefits potentially available from reducing unnecessary energy use, this is a priority analytical area.

II. NATURE OF THE ENERGY-ENVIRONMENTAL PROBLEM

The "energy crisis" and its relation to the environment has been the subject of growing public concern. This section attempts to clarify the nature of the energy-environmental problem. From EPA's point of view, the problem has two parts:

- National Energy Consumption and Supply Problem---the U. S. energy crisis exists only within the framework of existing national energy objectives. Current U. S. economic, public welfare and environmental policies define a set of future supply and consumption requirements which do not "balance." The national energy problem is to determine the best way to modify existing policy objectives to balance future energy supply and consumption.
- National Energy-Environmental Problem---EPA must ensure that environmental protection is given equal consideration, relative to other national objectives, in policy decisions required to match future energy consumption and the amount, mix, and form of energy supply.

1. RECENT TRENDS INDICATE THAT THE U. S. IS BEGINNING A BASIC TURNAROUND IN ITS ENERGY POSITION

Throughout its development, the U. S. has had generous supplies of low-cost energy raw materials available from its domestic resource base. [1/]

[1/] The single significant exception is growing oil imports, which have been held by government policy at less than 20 percent of U. S. consumption.

These historical conditions, however, may not continue in the future as indicated by the:[2]

- Recent growth of energy consumption at a rate faster than the GNP growth rate (reversing a longstanding relationship) resulting from population growth and increased per capita consumption.
- Failure of proved reserves of oil and natural gas to increase proportionally with consumption (a recent phenomenon for natural gas).[3]
- Decline in the thermal efficiency of converting fossil fuels to electricity (reversing a longstanding trend); electric generating efficiency declined from 32 percent in 1965 to 30 percent in 1970.[4]
- Deterioration of the natural environment, the mending of which will entail higher energy cost throughout the energy supply system--from mineral exploration through use.
- Doubts that nuclear energy will be available at costs as low as originally expected.

To the extent that imports are relied upon to fill any gap between consumption requirements and domestic supplies, recent trends in world oil markets suggest higher prices and raise doubts about the reliability of supply from the world's most prolific oil bearing regions--the Middle East and North Africa. Energy imports generally protect the environment by increasing the supply of relatively clean fuels and "exporting" pollution from extraction and refining processes. Imports, however, increase our reliance on foreign sources of supply, exacerbate the balance of payments deficit, and contribute to international monetary problems by concentrating large and volatile monetary reserves in a few countries.

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[2] Schurr, S. H., Energy Research Needs, Resources for the Future, Inc., Washington, D. C., October 1971.

[3] Proved reserves of crude oil and natural gas include only quantities that geological and engineering data demonstrate with reasonable certainty are available from known reservoirs under existing economic and operating conditions. Thus, proved reserves is an absolutely conservative estimate representing only 7.5 percent of oil-in-place in known conventional crude oil reservoirs and 1 percent of the total crude resource base originally in the earth's crust under the U. S. Typically quoted coal reserves, however, are more nearly akin to the total resource base.

[4] Op. cit.

A. The Energy Marketplace is Inhibited by Government Economic and Public Welfare Policy

A complete exploration of the effects of government (Federal, state, and local) policy on energy consumption and supply is beyond the scope of this effort. Bearing in mind the difficulty of generalizing about a complex body of policy and its impact, the key policies and their impact can be summarized as follows:

- Price Level: Final prices at the consuming level of all fuels/energy forms are set to varying degrees by direct or indirect government action. Prices have not been set for the purpose of influencing demand; instead, they have been set to stimulate mineral development; raise governmental revenues; produce "adequate" returns for the industries investing in resources, conversion capacity, and transportation and distribution facilities; and prevent world price levels from adversely affecting domestic supplies. Generally, then, the government role in pricing is to make final prices cheap (except in the case of excise taxes and import protection), which encourages consumption, and to stimulate the necessary supply, often by subsidies. Substituting for the "market" in this manner is technically and politically difficult; for instance, shortgages can occur where final prices are held below "market clearing" levels--the case now with natural gas.[5]

- Price Structures: Energy utility regulation typically encourages consumption by the way it structures rates. First, unit prices decrease as volume consumed increases. Second, utilities charge uniform rate schedules for broad classes of customers. These rates typically are based on average cost of supply; consequently, incremental consumption is not priced at its incremental costs. Finally, at various times, certain fuels (electricity, natural gas) provide promotional discounts to gain market share with respect to competing fuels. [6]

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[5] Generally, price has been an under-used policy tool in the energy area. This probably stems from the historical lack of any serious supply constraints. In addition, the discussion here is confined to the demand-supply impact of pricing policy; certainly, this policy area has many objectives which need to be considered before any hasty change is made. What is clear, however, is not that present pricing policy is wrong, per se, but rather that it generally is not even neutral with respect to encouraging consumption.

- Tax Policy: Because petroleum products provide more than 40 percent of the U.S. energy supply, tax policies aimed at petroleum dominate the energy scene. These policies indirectly control the price of petroleum which affects not only petroleum demand and supply but that of other energy sources as well. Oil and other mineral tax policies exist principally to stimulate discovery, development and production of reserves. These tax policies are, in the case of oil, intertwined with limitations on foreign imports and prorationing. [7] Because certain aspects of all three of these policies are contradictory, a "reliable" source can be found to defend any side of any issue regarding their singular and joint impact on supply and demand. An example of a contradictory policy is the 100 percent tax credit available to American oil firms for foreign royalties, which stimulates foreign rather than domestic development.

6/ Ibid.

7/ Prorationing consists of production limits, imposed by major oil-producing states, aimed ostensibly at preventing production at a rate which wastes oil. Simultaneously, however, it constrains supply to extant demand at prevailing prices; this not only maintains potentially artifically high prices, but, at least decreases exploration incentives and, maybe causes inefficient exploration and import limitations aimed at increasing domestic supply. Prorationing currently has little or no impact because domestic production is operating at capacity; nevertheless, the law and administrative mechanisms remain, thus discouraging further exploration.

- Import Policy: Like tax, import policy focuses on petroleum. Taken literally, oil import policy hinges on national security. In practice, however, the policy acts to protect essential petroleum consumption against foreign supply interruptions and to prevent import from causing a decline in the petroleum sector of the U.S. economy. [8/] Bolstering this broader view of import policy are recent changes in "petrochemical" crude import allocations; these mainly are justified on the general trade balance basis of keeping petrochemical industries domestically-based and competitive in world markets by providing access to lower-priced world crude. The higher domestic consumer price of oil, caused by current import policy, has a tendency to decrease oil demand. Given its contradictions with other policies aimed at increasing domestic oil supply, however, the impact of import policy on the amount of domestic supply is not clear.

- Public Land Management Policy: The U.S. government owns petroleum, natural gas, coal, oil shale, geothermal, hydro, and uranium resources. In 1968, receipts from the leasing and disposition of resources on leased lands exceeded $1 billion of which about 99 percent stemmed from oil and gas (about $9 billion related to Outer Continental Shelf oil and gas). [9/] Particularly for petroleum, production from Federal lands represented a significant portion of total U.S. production.

TABLE 1

1968: MINERAL FUELS PRODUCED ON FEDERAL LANDS [10/]

Mineral	Percent of Total U.S. Production		
	Onshore	Offshore	Total
Petroleum	8.7	5.9	14.6
Natural Gas Liquids	3.9	-	3.9
Natural Gas	7.7	5.5	13.2
Bituminous Coal	1.6	-	1.6

[8/] Cabinet Task Force on Oil Import Control, The Oil Import Question, Feb. 1970.

[9/] Bureau of Land Management, Department of the Interior, Public Land Statistics, 1968.

[10/] Abt Associates, Inc., The Study of Energy Fuel Mineral Resources, prepared for the Public Land Law Review Commission, Cambridge, Mass., 1969. Excludes uranium; 67 percent of production since 1947 was from public domain.

In the future the role of public land in U.S. energy supply should increase as oil, gas, and coal exploration are pushed further into environmentally sensitive offshore and wilderness areas (See Section V). Consequently, public land policy will be a key aspect of future U.S. energy supply. 11/

- Research and Development Policy: The Federal Government plays a large research and development role in energy areas where large technical risks and investment requirements (e.g., nuclear reactor development) and where the lack of immediate commercial viability may not adequately stimulate private efforts (e.g., conversion of coal to oil and gas). Consequently, Federal research and development policy will be a key aspect of future U.S. energy supply.

B. Environmental Policy Affects Energy Consumption and Supply in Four Major Ways

Despite the numerous policies influencing the U. S. energy position environmental policy often is considered a central factor for four reasons:

- It reduces the flexibility in the composition of the total energy supply, particularly in the short run.
- It amplifies already developing consumption and supply imbalances by increasing requirements for the fuels (oil, natural gas, and low sulfur coal) where domestic supplies were becoming tight.
- It increases consumption requirements and energy costs at many points in the supply system and at the final point of consumption.
- It adds a new set of considerations and extra uncertainty to energy decision-making at all levels.

11/ Also important will be the granting of "rights-of-way" for energy logistical facilities such as transmission and pipeline corridors and the use of Federal lands for energy facility siting.

Almost all -- certainly the most problematical from an energy viewpoint -- of these affect the supply side of the energy market place.

4. THE "CLEAN FUELS" DEFICIT IS THE MOST IMMEDIATELY PRESSING ENERGY-ENVIRONMENT PROBLEM[12]

The Clean Air Act of 1970 requires states to meet the primary (health) standards for sulfur oxides by 1975 and the secondary general welfare standards within a "reasonable" time. In fact, however, the state plans submitted to date are generally more stringent than required by the Act in two respects. First, the Act enables states to delay implementation of the secondary standards beyond 1975, subject to EPA approval; most state plans, however would achieve secondary standards by or before 1975. Second, in areas which already meet primary and secondary standards, states have imposed requirements which would produce even cleaner air.

Implementation of the SIP's for sulfur oxide control contributes to the clean fuels shortage by prohibiting the use of high sulfur coal and oil in many areas. This reduced flexibility of fuel supplies for stationary sources increases pressure on natural gas supplies (and prices) and rising oil imports.

A. Depending on the Course of the Response to the Clean Fuel Problem Arising from the SIP's, Total 1975 Oil Imports Could Rise by 13 to 45 Percent

Table 2, on the following page, shows the amount and types of fuels required for stationary source combustion in 1975 and 1977. These requirements assume implementation of State Air Implementation Plans as proposed by the States. The table indicates two things:

- **Even without SIP's, a shortage of natural gas will occur.**
- **A major deficit of coal acceptable for meeting SIP's will occur.**

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[12] **The material in this section is drawn from various EPA studies and analyses.**

TABLE 2: STATIONARY SOURCE: FOSSIL FUEL REQUIREMENTS AND AVAILABILITY

	Quadrillion BTU's	
Type Fuel	1975	1977
Natural Gas		
Available	24.8	24.3
Deficit	0.4	1.4
Subtotal	25.2	25.7
Coal		
SIP Acceptable [1/]	6.4	6.4
Deficit	6.7	7.8
Subtotal	13.1	14.2
Resid and Distilate	10.6	11.1
Total	48.9	51.0

Source: EPA Estimates

[1/] From 1970 Production

Of course, this represents the most pessimistic situation -- one where more low-sulfur coal and stack gas cleaning fail to materialize and SIP's to achieve secondary standards in these years are implemented. If these unlikely events occurred, however, the potential petroleum imports required to offset the combined gas and coal deficit is shown below:

TABLE 3: MAXIMUM 1975 IMPORT IMPACT OF TOTAL POTENTIAL CLEAN FUEL SHORTAGE[13]

Total Oil Imports Before Shortage	6,900 MB/D
Imports to Offset Total Shortage[14]	
Natural Gas	170
Coal	2,900
Total	9,970
Percent Change	44.5%

Table 4, on the following page, shows the 1975 and 1977 imports needed to offset this potential gas and coal shortage. At least four remedies are available:

- Low-sulfur coal made available from sources added after 1970 could offset about one-third of the deficit.

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[13] ICF estimates from EPA Clean Fuels Study Data and from NPC. Imports are MB/D resid equivalents of BTU shortage.

[14] Oil and Gas Journal (November 13, 1971) estimates these as 1750 MB/D (natural gas) and 3,700 (coal replacement) in 1975.

TABLE 4: POTENTIAL REMEDIES FOR SIP-RELATED COAL SHORTAGE

	Quadrillion BTU's	
	1975	1977
GROSS FUEL DEFICIT		
Natural Gas	0.4	1.4
Coal	6.7	7.8
Total Fuel Deficit	7.1	9.2
Oil Equivalent (Resid)	3.1 MMB/D	4.1 MMB/D
POTENTIAL OFFSETS		
Decontrol of Natural Gas	0.5	2.4[1]
New Coal	1.8	2.3
West Low-Sulfur	(1.08)	(1.56)
East Low-Sulfur	(.36)	(.40)
East High-Sulfur	(.36)	(.36)
Stack-Gas Cleaning	0.9	3.0
SIP Modification	2.4	-0-
Total Potential Offsets	5.6	7.7
Net Fuel Deficit	1.5	1.5
Oil Equivalent (Resid)	.6 MMB/D	.6 MMB/D

Source: EPA Estimates.

---

[1] 1977 is forced into balance, for the purposes of this table, by indicating the new natural gas required if incremental petroleum imports related to the clean fuel deficit are to remain at 1975 levels.

- Application of stack-gas cleaning could account for about ten percent of the deficit in 1975 and up to 35 percent by 1977.
- Selective delays of state sulfur regulation could offset about one-third of the deficit in 1975.
- If all of these offsets were available in 1975, EPA estimates the most likely increase in total imports would be as shown below:

TABLE 5: 1975 IMPORT IMPACT OF POTENTIAL CLEAN FUEL SHORTAGE OFFSETS

Total Oil Imports Before Shortage	6,900 MB/D
Imports to Offet	
Natural Gas (non-SIP)	170
Coal (SIP)	700
Total	7,770
Percent Change	12.6%

For 1977 the import impact is more difficult to calculate. More important than the absolute impact is the growing import stake inherent in bringing low-sulfur coal and stack gas cleaning on line in increasing amounts from 1975 to 1977. This occurs for two reasons:

- Potentially increasing gas shortages over the two-year period alone could account for an additional 440 MB/D import increase.
- 1975 SIP modifications provide a somewhat reduced offset in 1977.

B. Increased Use of Synthetic and Natural Gas May Partially Offset the Forecast Growth of Resid Imports, Even if the Development of Low-Sulfur Coal and Stack Gas Cleaning Proceeds Less Rapidly Than Expected.

(1) Natural Gas

The natural gas portion of any shortfall in fuel supplies for stationary source combustion could be offset partially by imports of liquified natural gas (LNG) or by imports of crude or feedstocks for synthetic natural gas production. At a minimu, both would require relatively rapid expansion of conversion and logistical facilities domestically.

Two other policy changes might affect the availability of natural gas. First, curtailment of gas supplies to interruptible customers (industrial and utility users) could occur; this would shift the natural gas shortage to petroleum, although it would not affect the overall clean fuels deficit itself. Alternatively, decontrol of natural gas prices could stimulate sufficient domestic production to eliminate, or at least substantially decrease, the shortage.

At this point, the final outcome is speculative. What is clear, however, is that it hinges primarily on natural gas prices and the response of supply to higher prices. To the extent adequate domestic supplies do not materialize, imports of crude refined into heating oils will make up the difference.

(2) Petroleum

Various levels of clean-fuel shortages, principally related to non-SIP acceptable coal, were projected to be offset by imports of resid. That might not be the 1975-outcome, for two reasons:

- Domestic oil production might increase, or
- Imports might be accounted for by crude rather than finished or semi-finished heating oils.

It is unlikely that domestic oil production can increase sufficiently, certainly not by 1975, to accommodate all increased U.S. consumption requirements, including those due to substituting oil for coal in stationary combustion sources. First, not only are production leadtimes for oil longer than for natural gas but one key domestic source--the Alaskan North Slope--probably will not be delivering to the U.S. (assuming that the U.S. rather than Japan is to be the recipient of North Slope production) before 1977 or 1978 even if a pipeline were begun now. Finally, except for import quotas, there is no imminent change in the exploration and development incentives for oil comparable to those likely for natural gas; and, recent experience indicates that shortages will be relieved by increased imports when supplies run short.

With respect to the second possibility, there exists at the moment a tight domestic refinery capacity situation; there is little spare capacity now to process additional imported crude. The willingness and ability of the petroleum industry to finance a major refinery expansion are not yet clear. On the one hand, a recent (February 5, 1973) Oil and Gas Journal survey indicates a 56 percent increase to $1.4 billion in refinery capital expenditures in 1973 over 1972. Most of these expenditures are to enlarge existing plants or replace marginal units, not to build new sites.

On the other hand, capital investment plans for refineries are subject to uncertainties due to a tightening domestic crude supply, delayed product specifications imposed by environmental considerations, site location problems, and price fluctuations. If refining capacity does not increase by 1975, imports of heating oils will fill the coal gap. In this regard, even offshore capacity to produce low-sulfur resid as well as tanker capacity probably will be tight in the face of the additional requirements which could accrue if the coal offsets (low-sulfur coal and stack gas cleaning) do not materialize.

C. The Development of Low-Sulfur Coal and Stack Gas Cleaning May Not Occur As Rapidly As Forecast, Thus Continuing The Clean Fuels Shortage Beyond 1977.

Environmental considerations generally introduce uncertainty, increase energy consumption and costs, and require a significant change in the status quo in an economic area prone to inertia. All three limit the prospects for both increased low-sulfur coal production and stack gas cleaning.

(1) Low Sulfur Coal

Switching exisiting boilers to low-sulfur coal makes utilities incur costs they otherwise could avoid, for several reasons:

- The locations of the key low-sulfur coal (Montana and Wyoming) compared to the location of utilities in the worst fuel bind (North Central states) makes the delivered prices of low-sulfur coal higher than current sources of coal (Central high-sulfur coal). Moreover, to stimulate greater amounts of coal from these sources, prices must rise above current levels. The combined impact by 1975 could make the delivered price of low-sulfur coal 70 percent higher than the prices for the higher sulfur coal now used. [15] In many cases, however, these prices can be passed forward quickly to consumers due to "fuel pricing" clauses built into utility regulation practices.

- Utility coal boilers are tailor-made to burn coal with a certain rank and flyash and moisture content. Once planned, the coal necessary to meet these design specifications is locked up by long-term contracts. The different properties of western low-sulfur coal cause difficulties in boilers now using high-sulfur coal. Existing generating plants with dry-bottom boilers, which can be modified for low-sulfur coal, experience lower generating efficiency and require shutdown for modification. Certain boilers (wet-bottom) appear not to be capable of modification, but instead require rebuilding and more extensive shutdown (these boilers account for about 1.0 Q or about 15 percent of the 1975 total potential clean coal gap), with subsequent efficiency losses could range up to 30 percent.

Because of this, three points are clear:

-- The known costs of switching to low-sulfur coal are close to the tentatively estimated costs of stack gas cleaning. This is partially offset by the ability to pass on the cost of low-sulfur coal to the consumer, whereas the capital costs of stack gas cleaning requires lengthy rate changes. The cost of stack gas cleaning, however, could decrease as technology and production efficiency improves.

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[15] Stephen Sobotka & Co., Economic Impact Analysis of State Implementation Plan Regulations on Fuels and Energy-Related Industries, October 13, 1972.

-- The costs and engineering uncertainty of low-sulfur coal conversion and technical uncertainty but potential cost competitiveness of stack gas cleaning make utilities inclined to hedge; this reduces their inclinations to enter long-term contracts for low-sulfur coal.

-- Market uncertainty is increased by the threat of new changes in the SIP's.

- Without long-term market confidence, new low-sulfur coal supplies will not be developed due to the capital commitment required (up to $500 million could be required to meet 1975 requirements.[16]) Uncertainty on the part of utilities as well as impending stripmine regulation both are significant barriers to low-sulfur coal supply development.

- Oil represents an alternative to low-sulfur coal, especially if the higher costs can be passed through to the ultimate consumers as environmentally necessary. Despite its likely premium over low-sulfur coal and stack gas cleaning, oil also has the advantage of known technology (and costs). It, too, represents a long-term commitment and conversion cost.

- Given economic and technical reluctance of electric utilities to shift from high-sulfur coal, triggering the necessary round of fuel switching or stack-gas cleaning depends on EPA's ability to present a "credible threat". Several factors erode that threat:

-- Financial penalties under the Clean Air Act are set at levels which make noncompliance cost-competitive with all alternative means of compliance.[17]

16/ Ibid.

17/ See Stauffer, "Alternative Solutions to Implementation Problems", November 16, 1972; equally serious is the possibility that regulatory commissions might allow these penalties to be passed through to consumers, thereby completely nullifying their incentives effect.

-- The magnitude of the overall problem of clean fuels is sufficient to stimulate hope for relief, either through modification of the SIP's or The Clean Air Act.

(2) Stack Gas Cleaning

The general logic which applies to utilities and low-sulfur coal applies to the prospects for stack gas cleaning. Absent the technical uncertainty surrounding cleaning, the two trade-off on an economic basis. [18]

At the moment, the status of stack gas cleaning has been assessed as follows: [19]

- Stack gas cleaning is technically feasible for commercial-sized installations; technology is not a limiting factor in its application. In addition, its full costs are competitive with low-sulfur coal (particularly in the Central Region where the utility clean fuel shortage is most acute). [20]
- The factors constraining stack gas cleaning are primarily (1) hesitancy of utilities to place orders, (2) vendor capacity, construction labor shortages and utility reserve margins--all of which limit the rate which stack gas cleaning can be brought on line after orders begin to flow and (3) waste disposal problems associated with open-cycle, wet scrubbing systems likely to make up the first generation of scrubber installations.
- The tactical problems of triggering utilities into action are similar to those for low-sulfur coal.

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[18] In the longer run, they also trade-off with processes to make high-sulfur coal clean and with accelerated plant retirements and shifting coal-fired boilers out of the baseload category and replacement with everything from new low-sulfur boilers to nuclear.

[19] SOCTAP

[20] In the short-run, however, cost recovery is inhibited, compared to fuel cost increases, due to their capital content and regulatory lag.

D. The Best EPA Strategy For Meeting The Clean Fuels Shortage Is Complicated By Many Factors Beyond Its Control

EPA faces a range of problems in developing a strategy for over-coming the shortage of clean fuels necessary to meet the air quality standards set under the Clean Air Act. Generally, the policymaking problem from EPA's point of view is complicated by two key things:

- The effectiveness of any strategy depends on many factors beyond EPA's control:
  - -- Government policy affecting domestic supply development, (natural gas and oil), import levels (oil), strip mining regulation (low-sulfur coal).
  - -- Utility regulation.
  - -- Technical development (stack gas cleaning).
  - -- The inclinations of the utilities to enter into long-term contracts for low-sulfur coal and to begin ordering stack gas scrubbers.
  - -- The inclinations of states to delay implementing secondary standards and, where secondary standards are being met, delay implementation of sulfur regulations.
- The EPA is caught between several forces, not of its own making, which are on a collision course with respect to the clean fuels shortage:
  - -- National concern about the foreign policy and national security effects of oil imports.
  - -- The fundamental role that energy consumption plays in the economy.

5. AUTO EMISSION CONTROL IS POPULARLY CONSIDERED TO BE A COMPLICATING FACTOR IN THE "CLEAN FUEL" DEFICIT.

There has been recent widespread discussion about the impact of auto emission controls on the energy "crisis". The discussion to date has been based on lack of understanding of the factors that affect auto fuel economy and the dynamic effects of future price increases for fuel and automobiles. On the basis of on-going EPA analyses, several conclusions emerge about the effect of emission controls on the energy supply situation.

A. If Nothing Else Changes, the Effect of Current-Planned Emission Control Standards Will Increase Total Fuel Usage 7-10 Percent By 1980.

EPA has analyzed the fuel economy effects of three alternative emission control systems:[21/]

- Oxidation and reduction catalysts to meet 1975 and 1976 Federal standards, using unleaded gasoline (Case I).
- Oxidation catalysts only, to meet 1975 Federal standards, using unleaded gas (Case II).
- Thermal reactors running rich, to approach 1975 Federal standards, with no change in gasoline (Case III).

Table 6 on the following page shows the estimated effects of these three systems on fuel economy, incremental gasoline consumption, consumer costs, and oil imports.

[21/] "Resource Requirements for Alternative Automobile Emission Control Strategies", EPA/OPE, January 2, 1973.

TABLE 6: 1980 RESOURCE REQUIREMENTS FOR ALTERNATIVE AUTO EMISSION CONTROL STRATEGIES

Outcome	Case I	Case II	Case III
Fuel Penalty as Percent of Total Base Fuel Requirement	7.6	0.0	10.4
Incremental Gasoline Consumption (Billion gallons/year)	8.0	0.0	10.9
Incremental Crude Oil Consumption (Thousand barrels/day)	599	75	712
Total Incremental Consumer Cost	8.0	2.8	8.1

Source: "Resource Requirements for Alternative Automobile Emission Control Strategies", EPA/OPE, January 2, 1973.

B. On the Other Hand, Many Factors Other Than Emission Controls Affect Fuel Economy. But There is Little Reliable Evidence About How These Factors Will Change in Response To Higher Fuel Cost, Decreased Fuel Economy, and Increased Auto Prices. Thus, it is Not Now Possible to Accurately Predict the Ultimate Effects of Emission Controls.

Many factors affect fuel consumption in an automobile: vehicle size, driving styles, type engine, power accessories (such as air conditioning), and the conditions under which the vehicle is driven (road gradient, temperature, pressure, etc.). Some of these factors (e.g., vehicle weight) are controllable by the auto owner. As the cost of fuels and emission controls increase, as well as auto prices, maintenance and operational costs, consumers are likely to look for savings elsewhere. The potential savings in fuel consumption from some controllable items are appreciable and could offset the increased consumption that results from emission controls.

- Automobile weight--weight is the single most important factor affecting auto fuel economy. A 1958 Chevrolet Impala weighs 37 percent less than its 1973 counterpart; in turn, the lighter vehicle consumes almost 30 percent less energy. Relatively small weight reductions could offset fuel consumption increases resulting from emission controls.

- Accessories--automatic transmissions and air conditioning increase fuel consumption. Tests indicate that air conditioning in full-sized cars increases fuel consumption by 9 percent. General Motors reports a fuel economy decline of 5-6 percent associated with the use of automatic transmissions. Like lighter vehicles, a decline in convenience options could offset emission control fuel economy losses.

- Engine--unconventional internal combustion engines, which might increase their share of the auto market, affect fuel economy in various ways. Preliminary indications suggest that the Wankel rotary engine would increase fuel consumption up to 35 percent. On the other hand, diesel engines could achieve up to 75 percent better fuel economy than conventional engines.

Thus, while the fuel economy loss due to new emission requirements could increase automative fuel consumption 7-10 percent by 1980, this potential increase could be offset by relatively small changes in auto weight and design, power accessories, and type engine.

6. THERE ARE NUMEROUS OTHER KEY INTERFACES BETWEEN ENVIRONMENTAL OBJECTIVES AND ENERGY.

The 1975-1977 clean fuel shortage and the energy impact of reducing auto emissions are two examples of the energy-environmental problem. Both merit particular attention because of their immediate and substantial implications for implementation of The Clean Air Act.

However, many others also fall within the broad framework of the energy-environmental problem. These relate to every other area of EPA authority (with the possible exception of pesticides) as well as to potentially forthcoming legislation (for example, strip mine regulation).

In the first round of EPA analytical effort on energy-environmental problems, all of these areas have been addressed, but only in preliminary fashion. Section V of this paper presents the results of this preliminary analysis, primarily to identify the key energy-environmental areas to which more analytical effort should be devoted in the future. Even the preliminary analysis highlights several key points:

- There is a pollution burden associated with all energy systems and particularly with all of those likely to make up the bulk of the U.S. energy supply through the balance of this century.
- Environmental penalties occur through the alternative systems; they not only occur at various stages during energy production, distribution and use, but also occur in different forms, in terms of pollutants and effects, environmental media and geographical locations.
- The state-of-the-art of being able to systematically and comprehensively identify and trade off the implications of alternative energy systems is rudimentary.

- As a result of the above, there are two areas of policymaking risk:
  - -- Obvious "solutions" may ultimately backfire
  - -- The lack of authority to "internalize" costs in all environmental areas (e.g., solid wastes)

Further EPA analysis on the energy environmental problem should focus on the following issues which are most likely to develop as the key environmental factors in future energy policy.

A. Plant Siting

Locations of markets and of energy raw materials define broad limits for siting major energy conversion installations (petroleum refineries, and power plants). Also, transportation/transmission technology and economics limit the positioning of these installations between markets and material sources.

Within these broad limits, however, there is considerable latitude in siting. The choice has significant environmental implications, for three reasons:

- The siting decision influences the kind of impacts and their geographical incidence (e.g., mine-mouth versus urban fossil-fuel electric power plants).
- Energy installations bring with them users of the energy (e.g., aluminum refining) and users of coproducts and byproducts (e.g., petrochemical processing associated with petroleum refining).
- The installation involves a comprehensive input and output logistical network (e.g., superports, pipelines, radioactive waste disposal sites, etc.).

The magnitude of the siting problem is indicated by Tables 7 and 8 on the following page.

TABLE 7: FUTURE ELECTRIC POWER GENERATION CAPACITY[1]

	Total Generating Units Installed				New Sites[2]
	1970		1990		1970-1990
Generating Capacity	No.	Ave. MW/Unit	No.	Ave. MW/Unit	No.
Nuclear	15	365	408	1100	160
Fossil Fuel-Steam	3298	80	1520	370	140
Other	-	n.a. - n.a.	- n.a.	-	99
High Voltage Transmission (line miles)		65,000		159,000	94,000

TABLE 8: FUTURE PETROLEUM REFINING CAPACITY[3]

	1970		1985		Change
	Capacity	No. Sites	Capacity	No. Units	
Refinery Capacity	10.9 MB/D	247	18.0 MB/D	4/	7.1 MB/D
Overland Pipeline	200,000		400,000		200,000

1/ Federal Power Commission, 1970 National Power Survey, V. I.

2/ Ignores expansions at existing sites.

3/ ICF estimates.

4/ New capacity probably will occur largely by expansion at existing sites.

B. Mineral Extraction

Both mining and drilling have environmental impacts which vary by location and extraction technique used.

There are three reasons why the relationship between mineral extraction and energy is of critical importance:

- Future oil exploration will push more and more into environmentally sensitive areas (offshore and, within that, the Pacific and Atlantic Coast areas).
- The conversion of coal to oil and gas--with attractive environmental implications at the point of use--entail a large mining commitment, much of which will be surface mining.
- The competitive economics of coal conversion and oil shale, with each other and with other fuels, probably hinge on the "environmental costs" internalized at the point of extraction.

The magnitude of the mineral extraction process through 1985 (during which coal conversion and oil shale will play only a minor role compared to their long-term potential) is shown in Table 9 on the following page.

C. Water Resources

Energy systems require water at many separate stages of their operation. Where water is required, water quality usually is decreased by the addition of organic and/or inorganic contaminants or by temperature increases.

In other cases, water is not directly required; but because it is there it is polluted (e.g., water impacts of mineral extraction). Conversely, other situations require water which is not available at the point where it must be used due, for instance, to the physical location of raw materials (e.g., oil shale). To the extent that these raw materials are exploited, significant quantities of water must be diverted.

TABLE 9: FUTURE MINERAL EXTRACTION ACTIVITY
NATURAL GAS AND PETROLEUM DRILLING[1]

	1971		1985	
Petroleum	No. Wells	Ave. Ft. /Well	No. Wells	Ave. Ft/Well
On-Shore	19,480		33,540	
Offshore	520		5,460	
Total	20,000	4,700	39,000	5,200
Natural Gas				
On-Shore	3,000		5,040	
Offshore	300		960	
Total	3,300	6,100	6,000	7,800

	Acres Disturbed Through Mining	
Surface Mining	Cumulative thru 1970	1975-1985
Coal	1.2 million	1.3 million
All other	2.8	n.a.
Total	3.0	n.a.
Underground Mining		
Coal	9.0	
All other	n.a.	
Total	n.a.	

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[1] Derived from tables presented in Section V.

There are three areas where energy has potentially large, future water resource implications:

- Heat rejection from electric generating plants.
- Water pollution stemming from underground and surface mining in water-rich areas (principally East of the Mississippi).
- Water diversion and consumption in the semi-arid West, partly for hydro-electric projects, but mainly as required for development of oil shale.

With the exception of stream pollution from mining -- largely a foregone pollution commitment from mining activity in prior years-- and heat rejection from power plants, water resources have not been systematically considered in current energy policymaking. More important in the future, development of Western mineral resources brings with it a potentially large water commitment in areas where water resources are a limiting consideration. Table 10 on the following page indicates the future magnitudes of these problems.

D. Energy Conservation

In the broadest sense, energy conservation has two major components:

- Efficiency improvements across the spectrum of energy production and consumption activity.
- Reduction in the rate of growth in energy consumption.

To some extent these improvements could be influenced directly by government policy (e.g., FHA Housing Construction Codes) or could occur as an incidental consequence of other trends (e.g., consumer switching to radial tires because of their non-energy-related properties).

TABLE 10: ENERGY-RELATED WATER RESOURCE REQUIREMENTS
U.S. POWER PLANT COOLING WATER REQUIREMENTS[1]

	Actual		Estimated
	1970	1980	1990
Electric Consumption (MWH x 10^6)	1,530	2775-3210	5026-6325
Cooling Water Requirement (ft 3/sec x 10^6	2.3	4.2-4.8	7.5-9.5
Increase Over 1970		80-110%	225-310%

UPPER MISSOURI WATER REQUIREMENTS[2]
(Thousand acre-feet per year)
Estimated

Process	1975	1980	1985
Montana			
Syngas	-	10	145
Syncrude	-	-	25
Electric Generation	10	50	150
Total	10	60	320
Available from Local Sources	---	110	----
Wyoming			
Syngas	-	20	70
Synacrude	-	15	125
Electric Generation	20	80	150
Total	20	115	355
Available from Local Sources[3]	---	130	----

---

[1] Federal Power Commission, 1970 National Power Survey. These estimates assume water is used only once. In fact, water can frequently be processed after use and used many times. Nevertheless, "once-through" water use estimates are generally used to justify major water projects, such as those proposed for oil shale.

[2] National Petroleum Council, U. S. Energy Outlook.

[3] Major diversion projects needed to supplement local sources require 8-9 years leadtime.

To a much greater extent, however, energy conservation is bound up in the response of energy demand to price changes. 22/ In turn, the ultimate price response in the energy area is related to two other issues:

- The dual role of energy in the economy: furnishing the wherewithal necessary to achieve whatever productivity and economic growth objectives are desired (some minimally-essential "requirement") and facilitating the enjoyment of goods and services made possible by such growth (a somewhat more discretionary "requirement"). 23/
- The long retrospective and prospective energy system leadtimes due to large long-lived capital investment already in place and long planning leadtimes for new capital investment.

With respect to both energy and environment, price effects on demand and supply are a large, analytically-weak area. This situation and the policymaking difficulties that result are apparent from the following:

- In the aggregate, price effects on total final demand may be of modest importance because the energy producing and conversion sectors of the economy account for only a modest proportion of GNP (not much over 5 percent).
- Because these energy sectors account for a large share of national capital spending (up to 20 percent), they are relatively insensitive to the short-run prices of fuels and relatively sensitive to the long-term estimates of energy reserves.

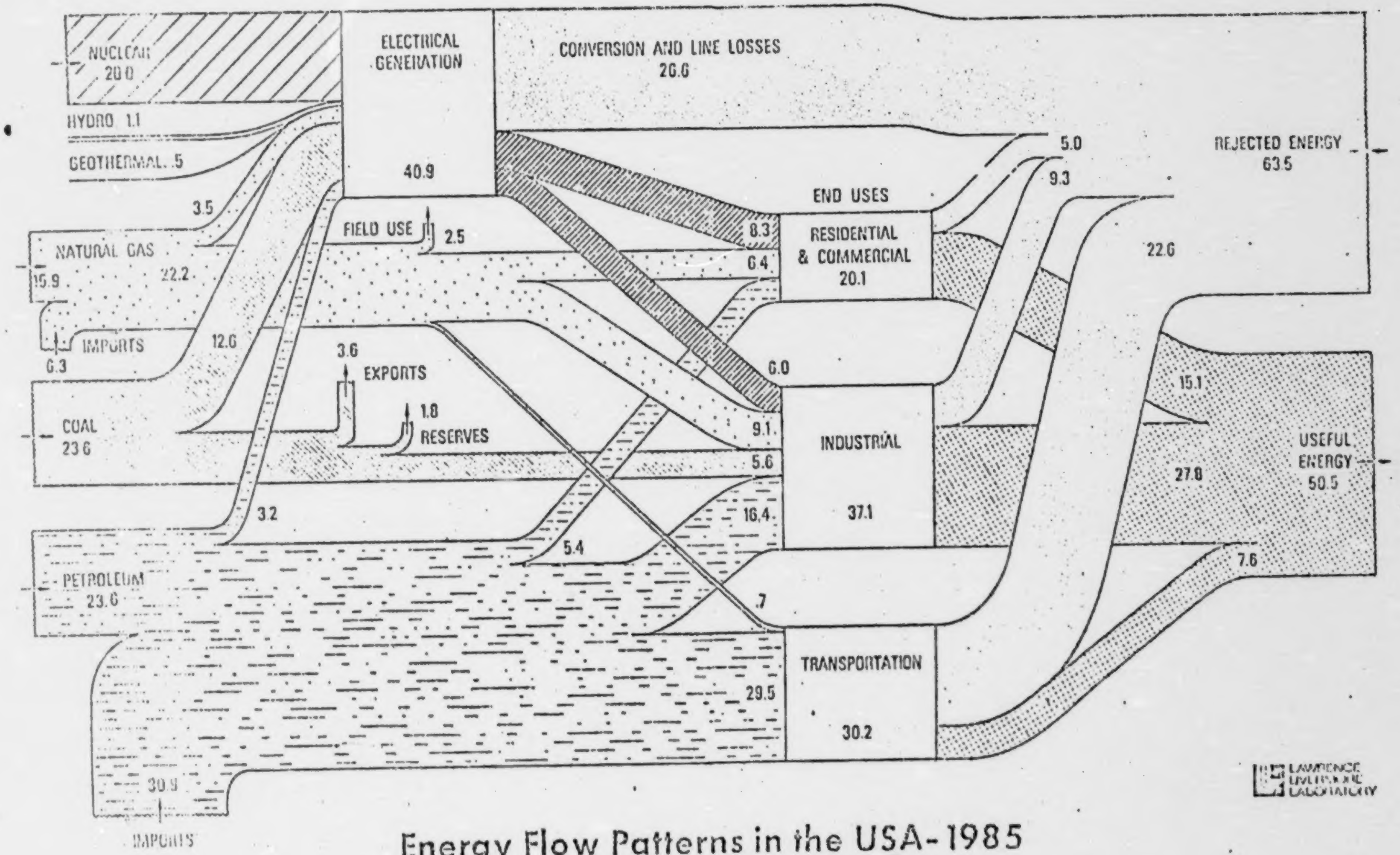
22/ It is worth mentioning in passing that price increases are a two-edged sword from an environmental viewpoint. Supply also responds to price; consequently, higher prices can make economic more marginal supplies (e.g., oil shale). If, and only if, environmental costs are correctly and comprehensively internalized, will all work out well from an environmental standpoint.

23/ Schurr, S.H., Energy Research Needs; Resource for the Future, October 1971.

- In the aggregate, prices probably have a moderate effect on energy demand in the manufacturing sectors of the economy because these sectors require higher than average energy input per unit of activity.
- Prices have a moderate-to-large impact on the mineral levels and energy forms making up the energy supply.
- Mineral reserves generally are understated (with the exception of coal) because reserve estimates remove price effects on supply; the effects probably are large in general and are known to be very large in some cases (e.g., uranium).
- In the aggregate, short run price effects differ substantially from long-run price effects because of the long-lead time and capital intensity inherent in energy; the directions of the short/long run differences, however, vary on a case by case basis because of these long leadtimes.
- All of these price effects are complicated by the myriad government policies impinging on energy.

The attractiveness of energy conservation through efficiency improvements is shown by the Figure on the following page which shows the overall heat rejection (a measure of waste) currently inherent in energy activities.

The sensitivity of consumption to efficiency changes is illustrated by Table 11 (on the subsequent page) which shows the contribution of thermal efficiency losses in electrical generation to the above average rate of energy consumption growth from 1960 through 1970.


NUCLEAR 20.0
HYDRO 1.1
GEOTHERMAL .5
3.5
NATURAL GAS 22.2
15.9
IMPORTS
6.3
12.6
COAL 23.6
3.2
PETROLEUM 23.6
30.9
IMPORTS
ELECTRICAL GENERATION
40.9
FIELD USE
2.5
3.6
EXPORTS
1.8
RESERVES
CONVERSION AND LINE LOSSES 26.6
8.3
6.4
6.0
9.1
5.6
16.4
5.4
.7
29.5
END USES
RESIDENTIAL & COMMERCIAL 20.1
INDUSTRIAL
37.1
TRANSPORTATION
30.2
5.0
9.3
22.6
15.1
27.8
7.6
REJECTED ENERGY 63.5
USEFUL ENERGY 50.5
LAWRENCE LIVERMORE LABORATORY

Energy Flow Patterns in the USA-1985

(ALL VALUES IN 10^{15} Btu. -TOTAL CONSUMPTION ≅ 122×10^{15} Btu.)

TABLE 11

CONTRIBUTIONS OF DIFFERENT COMPONENTS TO CHANGES IN U. S. ENERGY CONSUMPTION, 1960-1965 AND 1965-1970

	1960-1965		1965-1970			
End-use sector and type of energy consumed	Average annual percent rate of change	Contribution to average annual percent rate of change in total energy consumption[a/]	Average annual percent rate of change	Contribution to average annual percent rate of change in total energy consumption[a/]	Change between 1960-1965 and 1965-1970 in the contribution of different compound (col. 4 minus col. 2)	Percent contribution of different Components
	(1)	(2)	(3)	(4)	(5)	(6)
Households and commercial:						
Fossil fuels.....	3.05	0.69	3.51	0.78	0.09	6.4
Electricity	9.08	0.25	8.31	0.30	0.05	3.6
Industry:						
Fossil fuels.....	3.37	1.12	3.78	1.23	0.11	7.8
Electricity	4.58	0.13	6.84	0.21	0.08	5.7
Transportation:						
Fossil fuels.....	3.28	0.79	5.27	1.24	0.45	32.0
Electricity conversion losses	5.29	0.68	9.42	1.32	0.64	45.7
Total energy	3.65	3.65	5.05	5.05	1.40	100
In fuel and power uses..........	3.67	3.49	4.88	4.63	1.14	81.4
In non-energy uses	3.33	0.17	8.07	0.41	0.24	17.1

[a/] Weighted by relative contribution to nationwide energy consumption in 1960 and 1965.

Source: Schurr, S. H., Energy Research Needs; Resources for The Future; October, 1971

Note: Components do not add to totals because of omission of electricity consumption on transportation and a minor miscellaneous

III. U.S. ENERGY CONSUMPTION AND SUPPLY OUTLOOK

This section discusses alternative forecasts of U.S. energy consumption and supply [1/]. Specifically, it examines:

- Estimates of U.S. energy consumption, by economic sector.
- Alternative supply forecasts, by type fuel.
- Likely changes in the mix of fuels over time.
- Estimates of energy imports as the swing element in balancing supply and consumption.

1. TOTAL U.S. ENERGY CONSUMPTION IS FORECAST TO INCREASE 60-90 PERCENT DURING THE FIFTEEN YEAR PERIOD FROM 1970-1985.

Table 1 on the following page shows eight different estimates of total U.S. energy consumption in 1975, 1980, and 1985. Based on these eight estimates, energy consumption will increase from about 70 quadrillion BTU's in 1970 to somewhere in the range of 110-130 quadrillion BTU's by 1985.

The eight forecasts of U.S. energy consumption assume average GNP growth rates ranging from 3.5 percent to 4.5 percent per year. The higher estimates assume that energy consumption will grow continually at the 1960-1970 rate of 4.3 percent per year. The lower estimates generally assume that the growth rate will decline by 20-30 percent from the historical peak it reached in the 1960's. Consequently, the low estimates foresee annual growth of 3.5 percent, slightly above the long-term 3.2 percent energy growth rate for the U.S. during the Twentieth Century.

[1/] In this paper, consumption refers to an amount of energy actually used in the future. Demand refers to the hypothetical amount of energy which users would purchase at alternative prices. Forecasts of future energy consumption make implicit or explicit assumptions about energy demand and its price elasticity.

TABLE 1: ESTIMATED U.S. ENERGY CONSUMPTION
(Quadrillion BTU's)

Source of Estimate	Actual 1970	Estimated 1975	1980	1985
National Petroleum Council				
• Low	68	80	96	113
• Intermediate	68	85	103	125
• High	68	87	105	130
Department of Interior	68	80	96	117
Environmental Protection Agency				
• Baseline Study	68	88	108	124
• Energy Conservation Study	68	83	102	120
Oil and Gas Journal	68	83	102	NA
Lawrence Livermore Labs	68	NA	NA	122

Source: ICF, Incorporated. Individual estimates prepared by each organization as indicated.

2. FORECASTS OF U. S. ENERGY CONSUMPTION VARY OVER A WIDE RANGE BECAUSE ENERGY ESTIMATES ARE SENSITIVE TO A NUMBER OF KEY ASSUMPTIONS; EXTENDED TO THE YEAR 2000, THE DIFFERENCE BETWEEN HIGH AND LOW FORECASTS EQUAL THE TOTAL AMOUNT OF ENERGY CONSUMED IN 1970.

The most recent comprehensive forecast of U.S. energy requirements was compiled by the National Petroleum Council in its review of the U.S. Energy Outlook. The NPC estimated energy consumption under three different sets of assumptions about four major factors:

- Economic activity, as measured by gross national product.
- The cost of energy, including cost-induced efficiency improvements.
- Population growth.
- The effect of environmental controls.

The NPC made projections for these four factors which, they believe, bracket their most likely ranges. These outer bounds represent the high and low demand forecasts. The NPC "best guess" represents their intermediate estimate.

The NPC estimates of energy consumption in 1985 are highly sensitive to variations in these key factors. For example, total consumption under the low estimate is 113 quadrillion BTU's compared with 130 quadrillion BTU's under the high estimate, a 15 percent difference. To illustrate the magnitude of this difference another way, the difference between the high and low estimates in 1985 is equal to more than twice the total amount of petroleum imported in 1970.

A. Other Recent Estimates of Energy Consumption in 1985 Generally Fall Within the NPC High and Low Ranges.

- The latest forecast by the U.S. Department of the Interior estimates 1985 consumption at 117 quadrillion BTU's.
- Two recent EPA staff studies forecast 1985 consumption at at 120-124 quadrillion BTU's by 1985.
- Lawrence Livermore Laboratory estimates 122 quadrillion BTU's in 1985.

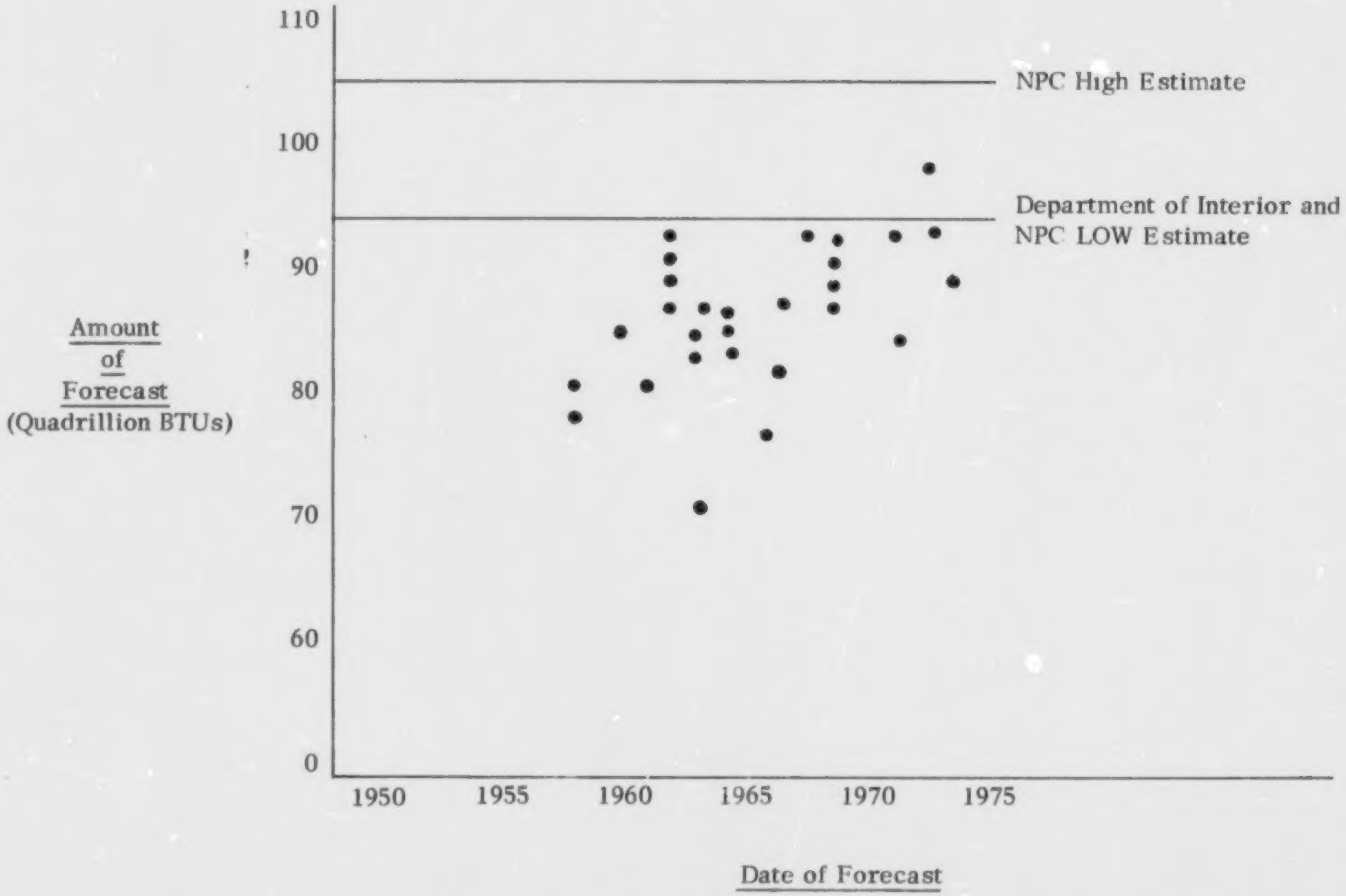
- The Oil and Gas Journal forecasts consumption only through 1980, but its 1975 and 1980 estimates are almost identical to NPC intermediate estimates. Extrapolating the OGJ estimate indicates total consumption of about 125 quadrillion BTU's by 1985.

B. Estimates of Energy Consumption Made Prior to 1970 Generally Fell Far Below the Best Current Forecasts and Covered a Wide Range, thus Reflecting the Uncertainty of Forecasting Energy Consumption.

Chart I on the following page shows 34 estimates of 1980 U. S. energy consumption made by energy experts between 1955 and 1971. Several conclusions emerge:

- 1980 consumption estimates increased over time as actual consumption exceeded expectations during the 1960's.
- The range of forecast uncertainty at any one point in time is appreciable. Four estimates all made in 1963 ranged from 73 to 86 quadrillion BRU's compared to current estimates of 96-105 quadrillion BTU's. Estimates made as recently as 1969 ranged from 88-98 quadrillion BTU's.
- With one exception, all 34 forecasts were below even the low NPC and the current Department of Interior estimates.

CHART I: ESTIMATED U. S. ENERGY CONSUMPTION IN 1980



3. THE ENERGY CONSUMPTION BY EACH END-USE SECTOR CHANGED LITTLE DURING THE LAST TWENTY YEARS. NO MAJOR CHANGES BETWEEN SECTORS ARE FORECAST THROUGH 1985.

Table 2 shows the relative consumption of energy by each ultimate consuming sector. Each sector's consumption includes its inputs of both primary energy (coal, petroleum, etc) and electricity. Typically electricity generation is shown as a separate sector; as a result, the final-use sectors which consume the electricity are understated.

TABLE 2: ENERGY CONSUMPTION [1/] BY ULTIMATE CONSUMING SECTOR

	Percent of Total U.S. Energy Consumption		
	1950	1960	1970
Residential/Commercial	28	30	30
Industrial	43	42	41
Transportation	29	28	29
Total	100	100	100

4. ELECTRICITY HAS INCREASED ITS SHARE OF PRIMARY ENERGY CONSUMPTION IN RECENT YEARS, THIS TREND IS EXPECTED TO ACCELERATE AT LEAST THROUGH 1985.

Table 3 shows the consumption of primary energy by consuming sector in 1950 and 1970. It also presents five alternative estimates of primary energy demand in 1985.

- Electricity conversion increased its share of total primary energy consumption from 15 percent in 1950 to 18 percent in 1970. Electricity's share of the total is forecast to increase to 25-40 percent by 1985.

[1/] Total sector inputs of primary energy and utility electricity allocated by sector.

Source: Energy Research Needs; RFF; 1971; Table 4.

TABLE 3: PRIMARY ENERGY CONSUMPTION BY CONSUMING SECTOR
(Quadrillion BTU's)

	Actual		1985 Estimated				
			NPC			EPA	
Demand Sector	1950	1970	Low	Inter.	High	Baseline	CEQ
• Residential/commercial	8	16	24	27	29	27	17
• Industrial	12	20	27	31	32	29	24
• Transportation	9	16	27	28	29	27	25
• Electricity conversion	5	12	27	30	31	33	34
• Non-energy	-[1]	4	8	9	9	8	10
Total	34	68	113	125	130	124	110

(Percent of Total Consumption)

	1950	1970	Low	Inter.	High	EPA Baseline	CEQ
• Residential/commercial	24%	24%	21%	22%	22%	22%	15%
• Industrial	35	29	24	25	25	23	22
• Transportation	26	23	24	22	22	22	23
• Electricity conversion	15	18	24	24	24	27	31
• Non-energy	-	6	7	7	7	6	9
Total	100%	100 %	100%	100%	100%	100%	100%

Source: ICF, Incorporated. Individual estimates prepared by each organization as indicated.

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[1] Non-energy breakout not available, included in other sectors .

- Non-energy users of energy as a raw material have increased gradually to about 6 percent of the total (4 quadrillion BTU's) in 1970. This sector is forecast to account for 7-11 percent of the total (8-14 quadrillion BTU's) by 1985.

- Industrial consumption of primary energy declined from 35 percent in 1950 to 20-25 percent in 1985.

5. MAJOR SHIFTS WILL CONTINUE IN THE RELATIVE IMPORTANCE OF ALTERNATIVE TYPES OF FUELS USED TO MEET U.S. ENERGY REQUIREMENTS.

Table 4 shows the relative contribution of each major fuel to total U.S. energy consumption in 1970 and forecast for 1985. Several conclusions emerge:

- The absolute consumption of every type of fuel will increase by 1985.

- Conventional oil and gas supplies will continue to account for over two thirds of the total.

- Coal consumption will increase significantly; however, its relative share in total energy consumption will continue its historic decline (at least through 1985). Total coal consumption is forecast to grow from 13 quadrillion BTU's in 1970 to 20-25 quadrillion BTU's in 1985. Nevertheless, between 1950 and 1970, coal's share of total energy consumption decreased from 38 to 19 percent; by 1985; it may decline to as little as 15 percent.

- Nuclear energy is estimated to grow rapidly, from less than 1 percent in 1970 to 16-17 percent of total consumption in 1985. As in the past, this forecast may overstate the potential growth of nuclear energy.

- Although both oil and gas will remain the major sources of primary energy through 1985, their relative roles are uncertain at present. Different assumptions about price, increased Federal leasing, and improved drilling and discovery rates affect supply forecasts dramatically, particularly for natural gas. Also, petroleum supply forecasts are sensitive to import policy. Consequently, the estimates range from 33 percent to 51 percent of total consumption.

TABLE 4: ALTERNATIVE U.S. ENERGY SUPPLY ESTIMATES
(Quadrillion BTU's)

Type Fuel	1970 Actual	1985 Estimated NPC I	NPC IV	EPA	DOI	Lawrence Lab.
● Oil	29	42	63	54	54	57
● Gas	23	41	23	24	34	22
● Hydro	3	3	3	3	4	1
● Geothermal	-	1	-	-	-	1
● Coal	13	18	20	23	21	24
● Nuclear	-	20	16	21	12	20
Total	68	125	125	125	125	125

(Percent of Total)

Type Fuel	1970 Actual	1985 Estimated NPC I	NPC IV	EPA	DOI	Lawrence Lab.
● Oil	43%	34%	51%	43%	43%	45%
● Gas	34	33	18	19	27	18
● Hydro	4	2	2	3	3	1
● Geothermal	-	1	-	-	-	1
● Coal	19	14	16	18	17	19
● Nuclear	-	16	13	17	10	16
Total	100%	100%	100%	100%	100%	100%

Source: See Table 6 for individual sources. NPC intermediate demand assumed for all forecasts and oil import estimates used as balancing item where necessary.

- Hydroelectric power will increase from 2.7 to 3.3 quadrillion BTU's during the fifteen year period, primarily through the development of small sites of less than 200 megawatt capacity located in the Western U.S. Its relative share of total consumption is expected to decline slightly from 4 percent in 1970 to 2-3 percent in 1985.

6. EVEN UNDER OPTIMISTIC ASSUMPTIONS, THE EFFECT OF NEW ENERGY SOURCES ON TOTAL ENERGY CONSUMPTION WILL BE SMALL UNTIL AFTER 1985.

Table 5 below shows the maximum contribution of unconventional energy sources to total consumption in 1970 and 1985.[2]

- Under a maximum development program, the total contribution from all the proposed unconventional uses of conventional fuels would account for only 6 percent of U.S. consumption.
- Synthetic gas from coal could provide up to approximately 2 percent.
- Synthetic crude from coal and oil shale, natural gas from nuclear stimulation, and geothermal power each account for a maximum of 1 percent by 1985.

TABLE 5: UNCONVENTIONAL ENERGY SOURCES
Trillion BTU's

	Trillion BTU's		1985, as a Percent of
Source	1970	1985	Total Consumption
Geothermal	7	1,395	1.1
Syncrude from shale	-	1,378	1.2
Syncrude from coal	-	1,489	1.2
Gas from nuclear stimulation	-	1,341	1.1
Syngas from coal	-	2,269	1.8
Total	7	7,872	6.4

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[2] These estimates are base on maximum feasible development programs proposed under NPC Case I.

Source: U.S. Energy Outlook; NPC Case I.

7. IMPORTED ENERGY WILL ACCOUNT FOR AN EVER INCREASING SHARE OF U. S. ENERGY CONSUMPTION THROUGH 1980. IMPORTS WILL BE THE SWING ITEM IN MATCHING U. S. CONSUMPTION AND DOMESTIC PRODUCTION. AFTER 1980, IMPORTS COULD DECLINE IF ALTERNATIVE DOMESTIC SOURCES OF ENERGY ARE DEVELOPED.

Table 6 on the following page shows alternative estimates of the mix of domestic and imported fuels in the U. S. energy balance in 1985. With one exception (NPC Case I), the role of imported energy will increase appreciably from present levels.

- Imported energy (petroleum and gas) amounted to 8.4 quadrillion BTU's in 1970, 12 percent of U. S. consumption.

- Imports are forecast to increase dramatically, from a low of 13 quadrillion BTU's to a high of 47 quadrillion BTU's by 1985. At these levels, imports would account for 11-38 percent of total U. S. energy consumption.

- The share of U. S. energy supplied by imports may peak before 1985, then decline. Table 7, on the subsequent page, shows the energy imports needed to balance consumption and domestic supply in 1970, 1975, 1980, and 1985. Oil imports as a percent of total oil supply range as high as 65 percent; gas imports range as high as 29 percent. Under two cases, however, reliance on imported fuels peaks in the 1975-80 perio . then declines as domestic production increases.

8. THE EFFECT OF PRICE CHANGES ON ENERGY CONSUMPTION AND SUPPLY IS UNCERTAIN. ALTHOUGH SOME FORECASTS CONSIDER PRICE EFFECTS, THESE UNCERTAINTIES MAKE THE VALIDITY OF ALL FORECASTS SUBJECT TO QUESTION.

All of the estimates of energy supply and consumption rest on critical assumptions about the price and income elasticities of energy. They all assume major price increases by 1985 and corresponding increases in domestic production. They all assume relatively inelastic demand.

One major weakness of all these forecasts is their common inability to accurately predict the responses of supply and demand to changes in prices

TABLE 6: DOMESTIC AND IMPORTED U.S. ENERGY, 1985

(Quadrillion BTU's)

	NPC				Baseline EPA	Interior	Lawrence Livermore Laboratory
	I	II	III	IV			
Domestic Production							
Oil	35	29	25	22	37	25[1]	24
Gas	35	29	23	16	26	28	16
Hydroelectric	3	3	3	3	3	4	1
Geothermal	1	1	1	-	-	-	1
Coal[2]	18	17	19	20	28	21	24
Nuclear[2]	20	18	9	16	21	12	20
Total Domestic	112	97	90	78	115	90	86
Imported Energy							
Oil	7	18	29	40	5	29	33
Gas[3]	6	6	6	7	6	6	6
Total Imports	13	24	35	47	21	35	39
Total U.S. Supply[4]	125	125	125	125	125	125	125

1/ DOI forecasts only total oil consumption, not by domestic and imported source. We have assumed domestic oil production equal to NPC Case III.

2/ NPC forecasts only total coal and nuclear energy used, not the mix between them.

3/ Imports of natural gas and LNG forecast only by NPC. We have assumed NPC Case III gas imports for all other estimates.

4/ Assumes NPC intermediate demand estimate of 125 quadrillion BTU's in 1985. Balancing item is assumed to be oil imports. Other individual estimates have been changed to reflect NPC demand.

TABLE 7: SHARE OF U.S. PETROLEUM AND NATURAL GAS SUPPLY DERIVED FROM IMPORTS

Supply Case	Oil Imports as a Percent of Total Oil Supply				Gas Imports as a Percent of Total Gas Supply[1]				All Imports as a Percent of Total U.S. Energy Supply			
	1970	1975	1980	1985	1970	1975	1980	1985	1970	1975	1980	1985
I	26	42	30	18	4	5	12	15	12	20	16	11
II	26	43	37	38	4	5	14	18	12	20	19	20
III	26	48	48	53	4	5	16	22	12	23	26	28
	26	51	66	65	4	5	18	19	12	26	38	38

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[1] A portion of the energy supply consists of gas reformed from petroleum liquids. To the extent that domestic liquids are reformed into gas, a corresponding increase in imported liquids would be required. Accordingly, for the purpose of the following energy balances, the energy in liquids reformed into gas and the input energy in gas reformed from liquids were both considered imported.

Source: U.S. Energy Outlook; National Petroleum Council; 1972.

and income levels. Historically, U. S. energy prices have experienced relative or absolute price declines while domestic supplies and production increased rapidly. As a result, empirical analyses of long-run supply and price relationships are limited in scope and value. In addition, little empirical evidence is available about how energy demand is likely to be affected by large (50-100 percent) increases in the price of fuels.

Uncertainty about aggregate energy price elasticities is compounded by our lack of knowledge about the likely elasticities of substitution among various types of energy. There are no empirical studies, for example, reflecting substitution effects which would occur if environmental protection costs are fully internalized in the price of fuels.

9. FORECASTING ENERGY CONSUMPTION AND SUPPLY IN THE 1985-2000 PERIOD IS, AT BEST, AN UNCERTAIN ART. NEVERTHELESS, THERE APPEARS TO BE GENERAL AGREEMENT ABOUT THE MAJOR THEMES DISCUSSED BELOW.

A. The Growth Rate In U. S. Energy Consumption Is Expected To Decline Somewhat After 1985.

In spite of increased economic activity, standards of living, environmental considerations, and electrical conversion losses, the annual energy growth rate is forecast to decline from 3.5 to 4.5 percent during 1980-85 to 2.5 to 3.5 percent during 1985-2000. This decline will result primarily from slower population increases, a more service-oriented economy, higher energy costs, and energy conservation as a result of such changes as smaller cars, multifamily dwellings, and increased mass transit.

B. Although The Annual Growth Rate May Decline, Total U. S. Energy Consumption May Triple By The Year 2000

Total U. S. energy consumption is forecast to grow from less than 70 quadrillion BTU's in 1970 to 170-215 quadrillion BTU's by 2000. The potential environmental implications of such an increase are staggering unless appropriate control technology is developed.

C. By 1985, Energy Technology Will Be Sufficiently Advanced To Permit Widespread Use of Conventional Fossil Fuels In Unconventional Ways.

Because of long lead times for new technology and capital investments, most new technology beginning in 1985 will be primarily to increase the use of conventional fuels in presently unconventional ways.

- Petroleum reserves should increase as new technology permits increased recovery efficiencies, deeper drilling, and, exploration of offshore and Alaskan areas.
- Gas supplies should increase as exploration and drilling grow. New technology may make nuclear stimulation and LNG commercially feasible.
- Coal technology will improve to the point that high-sulfur coal is environmentally acceptable. Underground and surface mining methods will improve.
- Nuclear power will increase its share of electrical generation capacity, and the breeder reactor should enter widespread commercial use.
- Synthetic fuels such as oil shale, tar sands, coal gasification and coal liquids will begin to be commercially available in quantity.

D. Radically New Energy Forms Will Not Probably Not Be In Widespread Use Until After The Year 2000

- Geothermal power will not increase appreciably until new deep drilling technologies are developed to exploit deep geothermal heat sources.
- Solar energy growth depends heavily on new technology to efficiently collect and store its power.

- Hydrogen Fusion represents a potentially limitless source of energy but is probably not commercially feasible until 2000.

These and other unknown technologies represent potentially important sources of energy. They will, however, require substantial research and capital investments; even under maximum development programs they are unlikely. to be commercially and economically feasible until after 2000.

IV. KEY ENERGY PROPOSALS

There are seven basic categories of policy proposals to close the gap between forecast energy requirements and energy supply.

- Maintain domestic supplies and meet increased demand by importing petroleum and natural gas.
- Increase domestic supplies by increasing domestic petroleum and natural gas production.
- Decrease petroleum and natural gas demand by converting more coal and nuclear resources to electric power.
- Increase domestic supplies by converting other domestic fossil fuel minerals to petroleum and natural gas.
- Reduce the impact of environmental protection on energy consumption and supplies.
- Decrease domestic consumption of energy resources.
- Increase domestic supplies by developing technology capable of tapping unconventional energy resources.

This section summarizes the results of EPA's review of these proposals and identifies key areas for further analysis.

1. THE CURRENT ENERGY PROPOSALS IMPACT ENERGY CONSUMPTION AND SUPPLY AT WIDELY VARYING POINTS IN TIME OVER THE NEXT TWO DECADES.

Research and development, exploration, and construction leadtimes in many parts of the energy supply and consumption system retard the rate at which policy changes can affect energy. In addition, current stocks of long-lived assets retard the practical rate at which some key portions of the energy system can change. As a result, the future points in time at which each current energy policy proposal impacts energy consumption and supply varies widely.

Table 1, on the following page, identifies the current proposals and indicates the approximate time period during which their impact on energy consumption and supply begins to be significant. On the subsequent page, Table 2 estimates the magnitude of their impacts on three future years: 1975, 1980, and 1985.

Four things are important to note about the second table.

- The impact measures are different for various activities (e.g., percent of oil imports, percent of total energy consumption, etc.). This correctly highlights policy actions which are key to specific portions of the overall energy system in the future. However, the role of any specific proposal (say, supertankers) may be affected by other proposals which influence the role of petroleum in the total energy supply.

- The percentage measures assume a successfully, import-minimizing energy strategy. This scenario is used to highlight the "best possible" impact of domestic resource-maximizing efforts.

- The table contains a few energy activities which may be influenced only indirectly by the current proposals and are not the primary focus of any specific proposal (e.g., overland oil and gas imports from Canada).

- The table cuts off at 1985 due to rapidly increasing forecasting uncertainties beyond that year. Consequently, some activities of apparently minor importance in the short-run could be of major importance beyond 1985.

Both tables indicate that most proposals will not affect energy supply and demand significantly until after 1980. On the one hand, this probably correctly reflects the long leadtimes inherent in many energy activities. On the other, the leadtime flexibility associated with the proposals has not been made explicit in formulating these proposals. As a result, decisions regarding environmentally damaging proposals such as oil shale may be made with unnecessary haste.

More specifically, the tables suggest the following conclusions:

TABLE 1: KEY FEDERAL ENERGY PROPOSALS

	Time Period When Proposals Begin To Significantly Impact Energy Consumption and Supply		
	1973-1979	1980-1985	1985-2000
I. IMPORT PETROLEUM AND NATURAL GAS			
• Expand Petroleum Import Quotas	X		
• Stimulate Greater Domestic Resid Refining Capacity Through "Bonus Tickets"	X		
• Construct Superports	X		
• Stimulate LNG Imports Through New Trade Agreements	X		
• Increase Canadian Natural Gas Imports	X		
II. INCREASE DOMESTIC PETROLEUM AND NATURAL GAS PRODUCTION			
• Accelerate Offshore Leasing Programs		X	
• Deregulate Interstate Natural Gas Prices		X	
• Employ Nuclear Devices to Fracture Tight Natural Gas Sands			X
III. DECREASE PETROLEUM AND NATURAL GAS DEMAND BY CONVERTING MORE COAL AND NUCLEAR RESOURCES TO ELECTRICITY			
• Develop Low-sulfur Coal Resources, Particularly Western Coal	X		
• Physically and Chemically Desulfurize High-sulfur Coal		X	
• Clean High-sulfur Stack Gases	X		
• Accelerate Licensing of Nuclear Plants		X	
• Develop Fast Breeder Reactor Technology			X
IV. CONVERT OTHER DOMESTIC FOSSIL FUEL MINERALS TO PETROLEUM AND NATURAL GAS			
• Convert Coal to Synthetic Petroleum and Gas			X
• Bring Oil Shale to the Point of Commercial Feasibility			X
V. MODERATE IMPACTS OF ENVIRONMENTAL PROTECTION ON ENERGY CONSUMPTION AND SUPPLY			
• Modify the State Implementation Plans for Air	X		
• Modify regulations for: Mobil Source Emissions, Strip Mining, Offshore Drilling and Plant Siting		X	
VI. DECREASE DOMESTIC CONSUMPTION OF ENERGY RESOURCES			
• Increase Gasoline Prices Through Higher Excise Taxes		X	
• Initiate a Voluntary Consumer-Use Conservation Program		X	
• Improve Extraction, Conversion, and Distribution System Efficiencies		X	
VII. DEVELOP TECHNOLOGY TO TAP UNCONVENTIONAL ENERGY RESOURCES			
• Support Development of "Exotic Sources"			X

TABLE 2:

CATEGORY		SPECIFIC ACTIVITY	PERCENT IMPACT: BY YEAR			MEASURED AS PERCENT OF:
			1975	1980	1985	
I. Import Petroleum and Natural Gas	(1)	Oil Imports	42%	30%	18%	Total Domestic Petroleum Consumption
	(2)	Resid Refining Capacity				Total Domestic Resid Consumption
	(3)	Oil Imports via Supertanker				Total Petroleum Imports
	(4)	Syngas Feedstock Imports				Total Domestic Gas Consumption
	(5)	LNG Imports				-do-
	(6)	Natural Gas Imports (Overland Pipe)	5	12	15	-do-
II. Increase Domestic Petroleum and Natural Gas Production		Total Petroleum Production - New Fields	17%	39%	50%	Total Domestic Petroleum Consumption
		Alaskan (all areas)	(2)	(14)	(18)	-do-
		On-shore, Lower - 48 States	(6)	(7)	(10)	-do-
		Offshore: All Areas	(9)	(17)	(23)	-do-
		Total Natural Gas Production-New Fields	≥ 4	≥ 22	73%	Total Domestic Gas Consumption
		Alaska: All On-shore Areas	(1)	(7)	(15)	-do-
		On-shore: Lower - 48 States	n.a.	n.a.	(37)	-do-
		Off-shore: Lower - 48 States	(3)	(14)	(21)	-do-
		Nuclear Stimulation	-	1	5	
III. Convert More Coal and Nuclear		Electric Consumption (input basis)	28%	32%	36%	Total Domestic Energy Consumption
		Coal - Steam Generation	11	14	11	Total Domestic Electric Generation
		Low-sulfur Coal	(2.8)			-do-
		Washed Coal	(0.3)			-do-
		Solvent Refined Coal	-			-do-
		Stack Gas Cleaning	(1.1)			-do-
		As-mined Coal ≤ .01%	(7.8)			-do-
		Nuclear Generation	5	7	15	Total Domestic Electric Generation
		Thermal Reactor, Fast-Breeder Reactors	(5)	7)	(15)	-do- -do-
IV. Convert Other Domestic Fossil Fuel Resources		Oil Shale - Synacrude	-	0.7%	3.5%	Total Domestic Petroleum Consumption
		Coal - Synacrude	-	0.4	3.5	-do-
		Coal - Pipeline Syngas	-	1.6	5.5	Total Domestic Gas Consumption
		Coal - Lo-BTU Syngas	-			-do-
V. Moderate Energy Impacts of Environmental Protection		Modify SIP's				
VI. Decrease Rate of Growth in Domestic Consumption of Energy Resources		Increase Gasoline Prices				
		Voluntary Consumer Conservation				
		Improve Efficiencies				
VII. Tap Unconventional Sources		Geothermal	0.1%	0.8%	1.1%	Total Domestic Energy Consjmption
		Exotic	-	-	-	-do-

- Nearly all proposals (Categories I through V) relate directly or indirectly to conventional fossil fuels (petroleum and natural gas).

- The basic rationale behind most proposals (Categories II through VII) is to increase domestic energy self-sufficiency as an alternative to increasing petroleum and natural gas imports.

- With respect to short-run supply and demand, there are only limited proposals which could be effective before 1980:

  - Import more petroleum and gas.

  - Increase low-sulfur coal production.

  - Modify the SIP's to permit increased use of domestic coal thereby lowering import requirements.

  - Stack gas cleaning.

- The 1975-1985 decline in oil imports hinges on:

  - Successful and significantly expanded petroleum and gas exploration, particularly offshore.

  - Increasing the share of total energy consumption devoted to electricity.

  - Maintaining the role of coal in electric generation.

  - Greater reliance on nuclear generating capacity.

- Proposals to convert coal and oil shale into synthetic petroleum and gas will provide no significant relief from dependence on conventional petroleum and gas until after 1980.

- Proposals to develop new high-technology energy systems (breeder reactors, solar power) will not provide significant energy inputs until after 1990.

2. THE CURRENT ENERGY PROPOSALS HAVE A WIDELY VARYING POTENTIAL FOR ADVERSE ENVIRONMENTAL IMPACT.

The broad U. S. energy strategy inherent in the current proposals is to increased domestic energy self-sufficiency. Since all energy extraction, conversion, distribution and use activities pollute, the environmental implications of more energy, and particularly more domestic energy self-sufficiency, are significant.

Although all energy systems pollute, their environmental effects can vary widely. First, because their impacts on total energy consumption and supply begin at different times, the potential environmental implications of alternative energy systems become significant at different points in the future. Second, alternative systems can differ environmentally in three broad ways:

- The specific pollutants produced (e.g., sulfur versus radiation).
- The media into which pollutants are introduced (e.g., sulfur oxides in air versus sulfur acids in water).
- The physical location where introduction occurs and, in turn, the elements of the environment which are affected (e.g., sulfur by-products of stack gas cleaning, conducted in populated areas, versus sulfur by-products of coal gasification conducted in remote, mining areas).

During the course of EPA's recent energy studies, an effort was made to evaluate the environmental, efficiency and cost impacts of alternative energy systems. This effort, performed in part by Battelle[1], compared the system-wide impacts of twenty-two alternative electrical generation systems.

Table 3, on the following page, displays the initial results of the analysis. Because the relative ranking of pollution effects (between air, water, and solid wastes, etc.) is tentative, the conclusions are only suggestive:

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[1] Battelle: Analytical Services in Connection with Long-Term Energy Supply and Least Environmental Cost Energy Production and Distribution (Interim Report); November 7, 1972.

TABLE 3: SUMMARY OF RANKED SYSTEMS, EFFICIENCIES, AND COSTS

System Environmental Index	System				Overall Efficiency	Overall Cost, mils/kwh
	Extraction	Transportation	Processing	Utilization		
3.03	None	Imported High Sulfur Resid	Fluid-Bed Combustor	Combined Cycle	.380	12.3
3.88	Nuclear Fission - Total System*				.300	-
4.09	Gas Well	Gas Pipeline	Desulfurization	Conventional Boiler	.336	-
5.43	Eastern Coal, D. M.	Rail	Physical Desulfurization	Conventional Boiler plus Limestone Scrubber	.315	-
6.38	Western Coal, S. M.	Rail	None	Conventional Boiler plus Limestone Scrubber	3.49	13.5
6.78	Oilwell, Off-Shore	Oil Pipeline	Domestic Refinery	Conventional Boiler	.305	12.3
6.87	Oilwell, On-Shore	Oil Pipeline	Domestic Refinery	Conventional Boiler	.305	12.3
7.05	Oilwell, On-Shore	Tanker	Domestic Refinery	Conventional Boiler	.305	12.3
7.06	Eastern Coal, D. M.	Rail	Physical Desulfurization	Conventional Boiler	.315	-
7.59	Eastern Coal, S. M.	Rail	Gasification, Low BTU Molt. Iron Comb.	Conventional Boiler	.329	-
7.60	Western Coal, S. M.	Rail	None	Conventional Boiler	.349	12.7
7.75	Eastern Coal, S. M.	Rail	Fluid-Bed Combustor	Combined Cycle	.378	11.6
8.28	None	Imported Crude	Domestic Refinery	Conventional Boiler	.308	12.3

TABLE 3 (continued)

System Environmental Index	Extraction	Transportation	Processing	Utilization	Overall Efficiency	Overall Cost, mils/kwh
9.07	Eastern Coal, S. M.	Rail	None	Conventional Boiler plus mgO Scrubber	.349	-
9.12	Eastern Coal, D. M.	Rail	None	Conventional Boiler	.350	-
9.64	Eastern Coal, S. M.	Rail	None	Conventional Boiler plus Limestone Scrubber	.349	12.6
9.91	Eastern Coal, S. M.	Rail	Physical Desulfurization	Conventional Boiler plus Limestone Scrubber	.314	13.4
9.92	Eastern Coal, S. M.	Rail	Gasification, Low BTU, Lurgi	Conventional Boiler	.244	-
10.68	Eastern Coal, S. M.	Rail	Solvent Refining	Conventional Boiler	.261	14.6
11.20	Eastern Coal, S. M.	Rail	Physical Desulfurization	Conventional Boiler	.314	11.0
12.80	Eastern Coal, S. M.	Rail	Chemical Desulfurization	Conventional Boiler	.331	10.4
13.21	Eastern Coal, S. M.	Rail	None	Conventional Boiler	.349	10.2

* Includes only environmental impacts resulting from normal controlled operation. Analysis of nuclear accident probability and effect is not complete at this time.

Source: Battelle Memorial Institute; 1972.

- There are large environmental and efficiency differences between alternative systems; the cost differences, however, are moderate.

- The relative weights assigned to environmental impacts significantly offset the conclusions (for example, the Battelle analysis assigned equal weights to all environmental effects, thus indicating relatively poor relative performances for energy systems with effects on a variety of pollution problems such as strip-mined coal systems).

Table 4 summarizes the environmental impacts on various media resulting from seven illustrative conventional energy systems. Table 5 compares the environmental impact of seventeen developmental technologies. One key conclusion that emerges is that many of the developmental technologies (fuel cells, thermionie, and MHD) are potentially more environmentally damaging than existing conventional energy systems (fossil or nuclear steam electric). In combination, the three tables demonstrate the value of a systemwide, multimedia evaluation of energy-environmental impact.

Unfortunately, the Federal government's capability to perform the type of analysis described above is limited. Consequently, its analysis of the current energy proposals is less systematic. However, the environmental implications and key policy issues associated with the current energy proposals are summarized below.

A. Increase Imports of Petroleum and Gas

The overriding objective of current petroleum and gas proposals is to minimize reliance on energy imports by increasing domestic self-sufficiency. For petroleum, policy objectives are mainly to prevent a large increase in the percent of total petroleum supply which is imported, to facilitate the use of supertankers and to increase the proportion of the residual supply which is refined domestically. In the case of gas, the objectives are mainly to facilitate LNG imports and overland pipe shipments of natural gas from Canada; petroleum-based feedstocks for synthetic gas, however, fall under the overall petroleum import policy objectives.

Petroleum and gas imports generally reduce pollution by:

TABLE 4: SUMMARY OF THE TOTAL WEIGHTED ENVIRONMENTAL FACTORS OF MODULES WITHIN A NUMBER OF SELECTED SYSTEMS

Extraction	Transportation	Processing	Utilization	Air	Water	Waste
Eastern Coal, S. M.	Rail	None	Conventional Boiler	6.18	0.54	260
Eastern Coal, D. M.	Rail	None	Conventional Boiler	6.18	0.51	32
Western Coal, S. M.	Rail	None	Conventional Boiler	3.24	0.54	106
Oilwell, On-Shore	Oil Pipeline	Domestic Refinery	Conventional Boiler	3.64	0.69	0
Oilwell, Off-Shore	Oil Pipeline	Domestic Refinery	Conventional Boiler	3.64	0.67	0
Gas Well	Gas Pipeline	Desulfurization	Conventional Boiler	1.70	0.51	0
Nuclear Fission -- Total System*				0.33	0.47	78

* Includes only environmental impacts resulting from normal controlled operation. Analysis of nuclear accident probability and effect is not complete at this time.

Source: Battelle Memorial Institute; 1972

TABLE 5

SUMMARY OF RESULTS DEVELOPMENTAL TECHNOLOGIES

Energy System	Environmental Impact Rating
Solar (residential heating and cooling; water heating)	1
Heat pump (residential heating and cooling)	1
Tidal	2
Solar (Satellite)	2
Thermoelectric (solar)	2
Geothermal - dry rock	3
Solar cells (photovoltiac)	3
Geothermal - natural	4
Solar - Rankine	5
Solar - Sterling	5
Solid waste utilization/incineration	6
MHD - closed cycle (nuclear)	7
Fuel Cells - fossil fueled	7
Fusion	7
MHD - open cycle (coal or char)	8
Thermionic (closed-nuclear)	10
Fuel cells - nuclear, H_2 fueled	10
Hydroelectric	2
Steam Electric - fossil fueled	9
Steam Electric - nuclear fueled (fission)	9

Source: Battelle Memorial Institute; 1972

- Increasing "clean fuel" supplies for stationary sources.[2]

- Avoiding natural gas and petroleum extraction from more environmentally marginal domestic sources.

- To the extent finished rather than unfinished products are imported, exporting pollution associated with petroleum processing.[3]

Conversely, petroleum imports shift environmental problems from air to water, by:

- Generally increasing the potential for tanker spills.

- To the extent petroleum flows from the Mideast and North Africa increase, increasing the potential for calamitous spills from supertankers.

Despite their general environmental attractiveness, increased petroleum imports conflict with other sensitive national concerns. In fact, nearly all of the current proposals are a reaction to the implications of ever-increasing petroleum imports in three policy areas:

- Reliability on foreign supplies to meet essential U. S. energy requirements.

- Adverse impacts on the general U. S. trade balance.

- International monetary instability caused by the concentration of highly volatile monetary reserves in a few countries.

It is difficult to generalize about these complex and interrelated issues. Nonetheless, the underlying factors are roughly as follows:

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[2] Increased petroleum supplies, however, may prevent price increases from reducing auto emissions. Since refinery and market economics currently favor gasoline production at the expense of hearing oils, imports probably benefit the environment with respect to stationary sources more than they cost the environment with respect to auto emissions.

[3] Some domestic refining capacity increase will be required to supply residual fuels to "clean fuel" deficient areas. It is difficult and expensive to transport residuals because PAD II (inland) needs clean resid; crude will most likely be piped into PAD II and refined into resid.

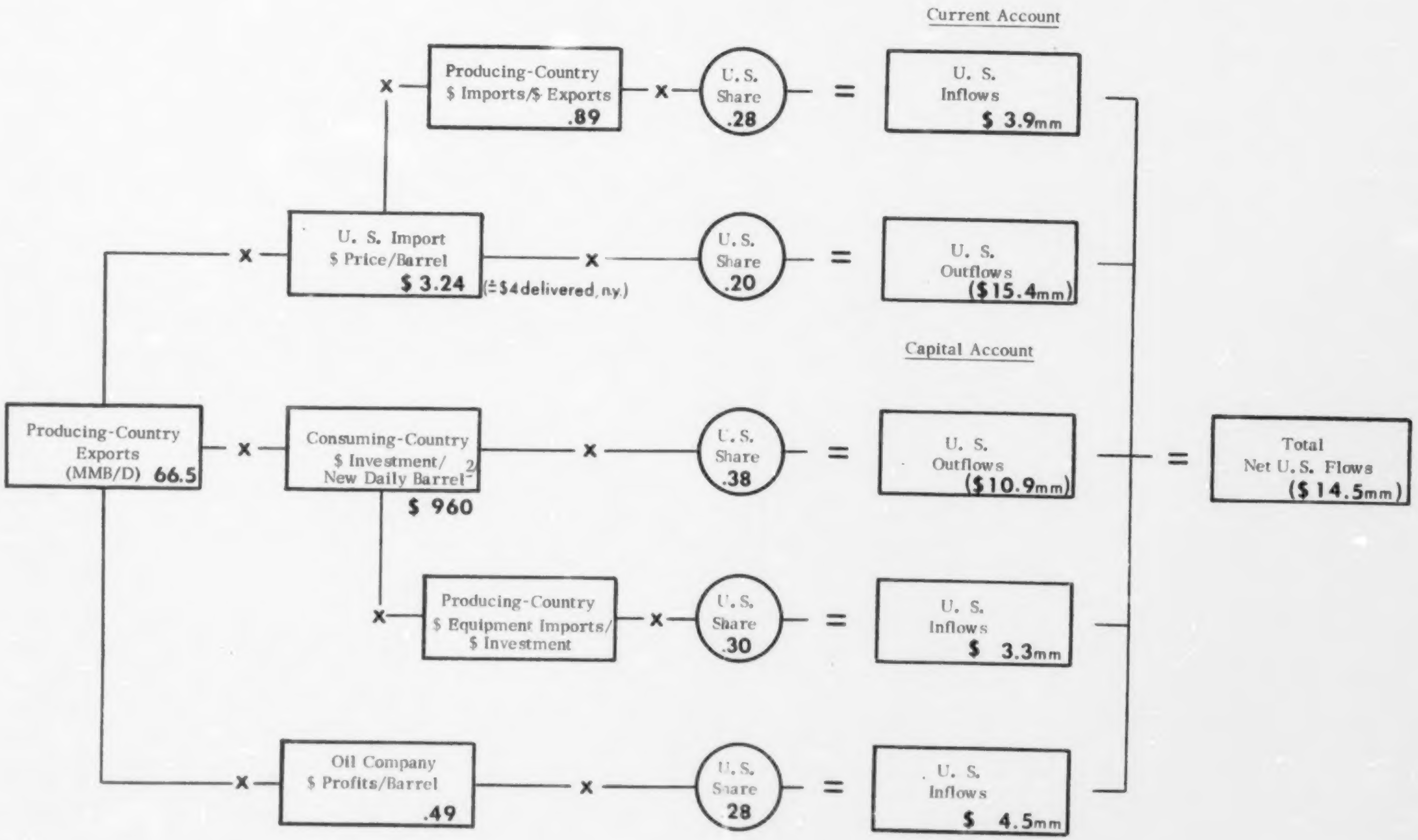
- All oil-consuming countries have increasing total petroleum requirements necessitating greater imports.
- These imports are concentrated in a few producing countries (principally in the Middle East and North Africa) which are generally underdeveloped and, as a result, create potential international trade and monetary problems by:
  - -- Not offsetting their export inflows with imports.
  - -- Building up large, liquid monetary reserves.
- There has been a recent shift of power from the consuming countries to the producing countries, which increases the risk of:
  - -- Accelerating price increases -- made independent of supply and demand in the form of taxes -- which amplify the trade and monetary problems per barrel imported.
  - -- Punitive supply interruptions.
  - -- Punitive movements of short-term currency holdings.
  - -- Encroachment into ownership of consuming countries' long-term capital stock.

Figure 1, on the following page, describes the general balance of payments flows arising from U. S. petroleum imports. Also shown is the adverse balance of payments from 13.0 MMB/D of petroleum imports in 1980 (a moderately pessimistic case[4/]). The producing countries which receive the U. S. balance of payment outflows in 1980 as well as in 1972 and 1975 are shown on the following page.

[4/] This is a pessimistic case; a change of 1 MMB/D in U. S. imports equates to a $1.2 billion reduction in U. S. outflows. Conversely, a $0.50 per barrel increase in Middle East prices equates to a $1.5 billion increase in U. S. outflows.

Source: ICF, Incorporated.

FIGURE 1 : 1980 U.S. BALANCE OF PAYMENTS FLOWS FROM PETROLEUM IMPORTS [1]


Current Account
Producing-Country $ Imports/$ Exports .89
U.S. Share .28
U.S. Inflows $ 3.9mm
U. S. Import $ Price/Barrel $ 3.24 (±$4 delivered, ny.)
U.S. Share .20
U.S. Outflows ($15.4mm)
Capital Account
Producing-Country Exports (MMB/D) 66.5
Consuming-Country $ Investment/ New Daily Barrel[2] $ 960
U.S. Share .38
U.S. Outflows ($10.9mm)
Total Net U.S. Flows ($14.5mm)
Producing-Country $ Equipment Imports/ $ Investment
U.S. Share .30
U.S. Inflows $ 3.3mm
Oil Company $ Profits/Barrel .49
U.S. Share 28
U.S. Inflows $ 4.5mm
x
=

---

[1] Dollar flows shown represent a pessimistic 1980 petroleum import situation; all factors are weighted averages of those applicable to various producing regions.

[2] In 1980, production at the assumed levels requires new daily barrels for reserve expansion and replacement of withdrawals, at the rate of 440 per thousand barrels produced.

Source: ICF, Inc.

TABLE 6: U. S. ENERGY BOP DEFICITS, BY PRODUCING REGION

($ Billions)

	1972	1975	1980
Canada	0.43	0.61	1.03
Other Western Hemisphere	0.96	1.11	2.28
Middle East	0.11	3.81	9.99
Other Eastern Hemisphere	0.38	0.59	1.27
Total	1.88	6.12	14.57

The current concern about the balance of payments effects of petroleum imports centers on their increasing concentration in the Middle East region. Traditionally, this region has not been considered "secure" from the U. S. perspective. Also, the balance of payments impact per barrel of Middle East petroleum imported is unusually adverse because producing countries in that region spend a smaller proportion of their export revenues on goods imported from the U. S., as shown below:

TABLE 7: SECOND-ROUND OIL-PRODUCING COUNTRY IMPORTS, BY PRODUCING REGION

	% of Export Revenues Spent on Imports	U. S. Share of Imports
Canada	50%	35%
Other Western Hemisphere	100	50
Middle East	85	20
Other Eastern Hemisphere	100	20

Source: ICF, Incorporated

B. Increase Domestic Petroleum and Natural Gas Production

The key ingredient of the energy self-sufficiency strategy is to increase domestic production of petroleum and natural gas. Table 2 at the outset of this Section, indicated the major role in 1985 of petroleum and natural gas produced from new fields in Alaska and offshore.

Two current policy proposals are aimed at stimulating the discovery of new petroleum fields. One, accelerated offshore leasing, acts directly by providing access to new exploratory areas. The second, import restrictions, acts indirectly by protecting domestic petroleum production lower-priced world petroleum supplies. A third policy, approval of the Alaskan pipeline, acts to stimulate development of already known fields by providing access to markets for petroleum produced there.

Accelerated offshore leasing also affects 1985 natural gas supplies. In contrast to petroleum, however, onshore areas are expected to provide a large share of new gas discoveries. (See Table 2.) In order to encourage domestic gas exploration, both offshore and onshore, decontrol of the prices of natural gas moving into interstate markets has been proposed.[5] The final natural gas proposal consists of initiating an experimental program to test the feasibility of releasing natural gas trapped in low-permeability sands in Western mountain areas with nuclear explosions. Due to its experimental nature, however, the impact of nuclear stimulation of natural gas supplies is expected to occur primarily after 1985 (See Table 2).

Increased domestic petroleum production has environmental implications similar to those associated with petroleum imports; both provide additional "clean fuel" for stationary sources (an environmental advantage) and additional gasoline for autos (a potential environmental disadvantage). Unlike imports, however, domestic petroleum from new fields may not be available in time to relieve the 1975-1977 clean fuel shortage by the time petroleum from new fields is available, increased domestic petroleum production may be less beneficial environmentally than imports.

Increased domestic petroleum production embodies greater environmental costs than imports, for two reasons:

- A large proportion of the new fields will occur in environmentally sensitive areas in Alaska and offshore.

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[5] Interstate shipments account for about 60 percent of marketed gas. Since one-third of these represent direct sales to major users (e.g., utilities), decontrol will impact only about 40 percent of the total natural gas market.

- Domestic petroleum will increase pollution from domestic refining (and associated petroleum-consuming industrial activity more than an equivalent amount of petroleum product imports).

The magnitude of the environmental impact of petroleum extraction depends on the rate at which production expands into marginal areas compared to the rate at which methods can be developed to protect the surrounding environment. There appear to be three acute problems:

- Preventing serious degradation of environmentally-sensitive Alaskan areas.
- Solving the environmental problems caused by drilling offshore in unstable geologic areas, particularly along the Pacific coast.
- Developing adequate extraction technology for deepwater areas on all coasts.

Unfortunately, the five potential alternatives to increased domestic petroleum production all have serious environmental implications:

- Increased diversion of natural gas to large stationary sources.
- Increased mining and sulfur wastes, particulates, and trace elements stemming from the direct substitution of coal for petroleum in stationary sources.
- Increased mining and sulfur wastes, particulates, and trace elements related to the conversion of coal to synthetic petroleum.
- Increased mining retorting wastes, water diversion, and water pollution resulting from acceleration of the oil shale development program.6/
- Increased mining, sulfur wastes, thermal pollution, and radiation caused by a shift to electricity.

6/ Acceleration of oil shale development may require the application of more inferior extraction and processing technology than could be developed given more time.

A similar dilemma applies to increased natural gas production, but to a lesser degree because: [7]

- A greater proportion of new fields will be located onshore.
- Nonassociated natural gas extraction does not cause serious environmental problems.
- Domestic natural gas production leads to less refining than petroleum production because only about 13 percent of the extracted fraction (natural gas liquids) requires further processing.

C. Decrease Petroleum and Natural Gas Demand by Converting More Coal and Nuclear Resources to Electricity

There are two major ways to substitute coal and nuclear energy for scarce petroleum and natural gas supplies.

- In the short-term, low-sulfur coal can be substituted for high-sulphur coal at electric power plants in an effort to solve the clean fuels shortage.
- In the longer-term, electric power (generated from coal and nuclear fuels) can increase its share of total energy, thus reducing the direct consumption of petroleum and gas.

Three of the current proposals address short-term substitution:

(1) Development of low-sulfur coal resources, particularly in Western areas;

(2) Development of technology to remove sulfur from high-sulfur coal; and

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[7] The five energy alternatives for domestic petroleum also exist for domestic natural gas.

(3) Development of technology to remove sulfur oxides from stack gases.

Since nuclear power probably cannot replace coal immediately and petroleum and natural gas supplies cannot support a rapid rate of growth in electrical power consumption, these three proposals also affect substitution in the longer-term. Two other proposals, however, primarily address the longer term:

(1) Streamlining electric plant licensing procedures, particularly from nuclear plants, and

(2) Research and development aimed at fast breeder reactors.

Taken together, these proposals imply a seven-part, phased strategy to reduce the role of conventional petroleum and natural gas in stationary source combustion and to reduce the stationary source sulfur oxides air pollution problem. The strategy elements are:

Short Term

- Minimize substitution of petroleum and natural gas in large stationary sources in response to clean fuel shortage (low-sulfur coal).
- Develop technology (stack gas cleaning) to maintain the viability of high-sulfur coal as a direct combustion product in large stationary sources.

Intermediate Term

- Develop technology to convert coal to synthetic petroleum and gas for direct use by all stationary sources.
- Increase coal and nuclear-generated electricity's share of the end-use stationary source market.
- Reduce the role of coal in electrical generation with nuclear fuels in thermal reactors.

Long Term

- Develop technology to improve the energy yield of nuclear resources (fast breeder reactors).

- Initiate research in "exotic" technologies to tap nonmineral energy resources (fusion, solar energy, etc.).

From a resource point of view, this is a complex strategy, the outcome of which depends on the resolution of uncertainties in three areas:

- Technical uncertainties--ranging from stack-gas cleaning in the short term to breeder reactors and exotic sources in the long run.

- Price-supply uncertainties--ranging from petroleum and natural gas in the short term to uranium in the long run.

- Relative-cost uncertainties--ranging from nuclear versus coal-based electrical generation in the short term and electricity versus coal synthetics in the long term.

The short-term portion of this strategy--the reduction of air pollution from coal-fired electric plants--is the least uncertain and is an improvement environmentally over the status quo.[8/] In contrast, the moderate and long-term environmental implications of this overall strategy are potentially adverse in two respects:

- Mining greater amounts of coal, disposal of sulfur once removed from coal, and handling of nuclear materials.

- Potential amplification of these impacts inherent in decreased system-wide efficiencies associated with "all-electric" energy.

[8/] This assumes that the impact of mining of low-sulfur coal is no worse than the high-sulfur coal mining that would occur otherwise and that disposal of sulfur wastes from stack gas cleaning is no worse than the SO air pollution problem.

D. Convert Other Domestic Fossil Fuel Minerals to Petroleum and Gas

Coal (and, to some extent, oil shale resources) are so vast compared to those of conventional petroleum and natural gas that they probably will be exploited at some future point to produce synthetic petroleum and gas. How soon this will happen, however, depends on the relative prices, at their point of use, of conventional and synthetic petroleum and natural gas. In addition, the amounts used depend on their demand at these prices, where substitution for petroleum and natural gas is infeasible or uneconomical, as well as on prices of other fuels where substitutes exist.

Unless the growth rate in the demand for natural gas declines, synthetic gas from coal will become significant by 1985 and could represent a sizeable share of the energy market by the year 2000.[9] The type of synthetic gas produced in the future could vary. Coal can be converted to either high-BTU gas economically capable of transmission by pipeline or a low-BTU gas, which must be used near its point of manufacture. In order to serve some portions of the gas market (e.g., residential), high-BTU gasification will be necessary. Low-BTU gasification, however, will depend on the comparative transportation economics of coal and pipeline gas from the perspective of a gas-steam cycle central power station. The magnitude and timing of synthetic gas' future role will be influenced by three other factors:

- The cost of stack gas cleaning -- low-BTU gas from coal, in combination with a gas-steam cycle turbine, may produce electricity at a cost comparable to coal-steam generation with stack-gas cleanup; consequently, low-BTU coal gasification may grow rapidly to replace direct combustion of coal for power generation.

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[9] Hottel and Howard, New Energy, Some Facts and Assessments, MIT Press, 1971. This is based on tentative engineering cost data which indicate that the costs of synthetic gas from petroleum and imported LNG equal the cost of gasified coal.

- The availability of oil shale -- because petroleum costs about half as much to transport by pipeline as gas and syncrude can be extracted from oil shale at a cost no greater than producing pipeline quality synthetic gas, syncrude made from shale may substitute for pipeline quality syngas. Since about 80 percent of the premium oil shale deposits underlay Federal lands, governmental land management policy affects the future of high-BTU coal gasification.

- Government mining and water resources policies -- oil shale conversion technology is simpler and probably cheaper than coal conversion technology. Oil shale development, however, is limited by water availability; also, coal yields four times more energy per ton of mineral extracted, which provides a comparative mining advantage over oil shale. Consequently, government water resource and mining policy can significantly impact the comparative economics of synthetic crude from coal versus oil shale and, in turn, the comparative economics of both synthetic crude versus synthetic gas and synthetic versus conventional petroleum and natural gas.

In the absence of Federal regulations and a vested interest on the part of pipeline companies in maintaining adequate returns on their existing pipeline investments, the close economics of various synthetics would make their future difficult to predict. Because that is not the case, government policy and pipeline company decision-making will, to a large extent, determine the outcome. Unfortunately, from an environmental standpoint, the best result is not immediately clear cut due to the different impacts which arise from all of the alternatives. Based on the initial EPA analysis, however, oil shale appears to be the least attractive alternative environmentally.

E. Moderate The Impacts of Environmental Protection On Energy Consumption and Supply

In the first section of this report, five reasons why environmental protection and traditional energy policy conflict were outlined, as follows:

- It reduces the flexibility in the composition of the total energy supply, particularly in the shortrun.

- It amplifies already developing consumption and supply imbalances by increasing requirements for the fuels (oil and natural gas) where domestic supplies were becoming tight.
- It increases consumption requirements and energy costs at many points in the supply system and at the final point of consumption.
- It adds a new set of considerations and extra uncertainty to energy decision making at all levels.
- It requires a change in the status quo at a rate greater than the inertia-prone energy consuming and supplying sectors are used to experiencing.

In terms of the current energy proposals and the U. S. energy problems at which they are aimed, the environment affects six areas:

- The "clean fuel" shortage related to air SIP's.
- Increased petroleum consumption resulting from auto emission controls.
- Delays in power plant licensing.
- Increased energy consumption associated with environmental controls and other environmental protection activity.
- Uncertainty over future mining regulation.
- Uncertainty over future environmental standards in general.

To the extent that the energy policy response to these impacts can be generalized, it consists of advocating a more "reasonable" course of action with respect to environmental protection.

The clean fuel shortage and auto emissions previously were discussed in detail in Section II. From any energy standpoint, they are transitional problems which are most acute in the period before 1980. They will continue after 1980 only if major energy producers (e.g., electric utilities) and major segments of the energy consumers (e.g., auto owners) persist in maintaining the status quo.

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The remaining energy-environmental conflicts are more difficult to discuss in detail. Two things, however, are reasonably clear:

- Electric power plant construction is delayed by more than just environmental problems; as shown in Table 8 on the following page, an equal number of delays are expected to result from non-environmental factors. The narrow "reserve margins" existing currently with respect to power generation, construction delays, and industry reservations about nuclear plant safety, reliability and cost performance will make electric generation capacity tight well into the 1980's.

TABLE 8: REPORTED DELAYS IN SCHEDULES OF STEAM-ELECTRIC GENERATING UNITS, 300 MEGAWATTS AND LARGER

	Number of Units Affected by Years			
	1966-1970 Totals	1971 2/	1972 2/	1973 and Later 2/
Status of Units				
Units delayed	83	19	22	70
Units on schedule	17	23	28	121
Units ahead of schedule	14	5	10	15
Total number of units	114	47	60	206
Causes or Contributing Causes of Delays 1/				
Labor Related				
(1) Shortage of construction labor	25	1	5	2
(2) Reduced labor productivity	9	1	4	1
(3) Strikes	31	8	6	2
Subtotal	65	10	15	5
Other Causes				
(4) Equipment failure, faulty installation, start-up problems	29			
(5) Late delivery of equipment	17	6	6	4
(6) Inability to obtain necessary certifications and other regulatory impediments, including environmental problems	8	4	5	35
(7) Adverse weather	2	1		
(8) Planned deferments due to changes in load estimates	2	1		5
(9) Design changes	1		1	2
(10) Budget or financing problems		6	6	30
Subtotal	59	18	18	76
Total	124	28	33	81

1/ The same unit may be reported as delayed by more than one cause. Therefore, the sum of causes for delays may exceed the total number of units delayed.

2/ Status as of January 1, 1971.

Source: Federal Power Commission; The 1970 National Power Survey.

TABLE 9: ENERGY CONSUMPTION TO MEET ENVIRONMENTAL STANDARDS

(10^{12} BTUs)

Activity	1980		1985	
	1/	2/	1/	2/
Auto Emissions Controls	914	-	400	-
Electric Utility Industry				
Control of Waste Heat	-	247	-	1,331
Control of NO_X (Coal)	-	252	-	471
Control of NO_X (Residual Fuel Oil)	-	45	-	76
Fuel Desulfurization (Residual)	120	119	202	202
Stack Gas Scrubbing (Coal)	63	63	117	118
Total	183	726	319	2,198
Sewage, Water and Solid Waste Treatment	2,000	2,542	2,432	2,580
Other Solid Waste 3/	-	-	-	-
Industrial Sector				
Residual Oil Desulfurization (to 0.3% S)	-	167	-	304
Coal Gas Scrubbing (Equivalent to 0.3% S)				
Coking	-	50	-	71
Industrial 4/	-	35	-	43
Other Environmental Control by Industry	976	244	1,298	972
Total	976	496	1,298	1,390
Consumption for all Environmental Controls	4,073	3,764	4,449	6,168
Total Energy Consumption -- Initial Appraisal	102,581	-	124,942	-
Environmental as Percent of a Total Energy Consumption	4.0	3.7	3.6	4.9

1/ Approximate quantities included in Initial Appraisal.

2/ Additional energy requirements because of higher environmental standards subsequent to the Initial Appraisal.

3/ Forecast that BTUs gained by burning will equal BTUs required for gathering and disposal.

4/ Including a relatively small amount for residential/commercial.

Source: U. S. Energy Outlook; National Petroleum Council, 1972.

- Concern over mining regulation is warranted because future energy trends imply an increasing reliance on mining of coal and oil shale. Without environmental controls, the majority of this mining would be accomplished by stripping; since strip-mining appears to be a major environmental problem, at least the economics of future coal and oil shale energy supplies hinges on environmental regulation.

The energy consumption implications of controlling pollution are less clear. Table 9, on the preceding page, shows the NPC estimates of future energy consumption to meet environmental standards. 10/ For two years, 1980 and 1985, the table shows the consumption expected and the additional consumption resulting from higher environmental standards in several areas. Based on the table, environmental-related energy consumption could represent from about 4 percent to 9 percent of total U. S. energy consumption in both years.

Table 10, on the following page, indicates the distribution of this consumption by key economic sectors.

These estimates are questionable particularly because of the unidentified energy consumed by solid waste collection and disposal in the municipal-type services sector. Nonetheless, they suggest several things:

- Provided the auto mix shifts to more efficient, smaller cars, the energy consumption impact of auto emission is temporary.
- Municipal-type services consume about half of environmentally-related energy; with higher standards (presumably for water) these services account for roughly half of the increase in energy consumption.
- Although electrical generation accounts for a relatively small share of consumption under the expected standards, it accounts for about 25 percent of the increase resulting from higher standards (mainly due to waste heat control).

10/ National Petroleum Council, U. S. Energy Outlook, December, 1972.

- Industry is the least affected, in terms of energy consumption, by either the expected or higher standards.

TABLE 10: DISTRIBUTION OF ENVIRONMENTAL ENERGY CONSUMPTION BY SECTOR

	Percent of Energy Consumption For Environmental Control (with Expected Standards)		Percent of Increased Consumption (to meet Higher Standards)	
	1980	1985	1980	1985
Auto Emissions	22%	9%	0%	100%
Electrical Generation	4	7	19	36
Municipal-Type Services	49	55	68	42
Industrial Controls	24	29	13	22
Total	100%	100%	100%	100%
(Quadrillion BTU's Consumed)	(4.1Q)	(4.4Q)	(+3.8Q)	(+6.2Q)

Source: Derived from Table 9, herein.

F. Decrease Domestic Consumption of Energy Resources

A general damping of the rate of U. S. total energy consumption could provide three direct benefits:[11]

- A reduction in the magnitude of the environmental problems caused by energy production and use.

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[11] Science, 178, 4066, p. 1186.

- A reduction in the supply problems caused by shrinking domestic reserves of petroleum and natural gas.

- A reduction in the international economic penalties of importing ever-increasing amounts of petroleum.

In addition, a reduction in the energy growth rate could decrease the urgency with which near-term options need to be pursued and buy time to examine alternatives and to develop improved, less-polluting energy systems.

Even small percentage savings of energy can contribute substantial benefits. For instance, a one-percent saving in 1970 would have been equivalent to about 100 million barrels of oil that year; in future years, however, the annual savings would both compound and cumulate because of the nonrenewable nature of energy minerals. In addition, the environmental benefits would increase annually because the savings would be applied first against the exploitation of environmentally-marginal areas and the use of marginal fuels.

Energy can be saved in two ways: first, by reducing the amount of "work (for example, lighter autos); and second, by reducing the amount of "waste" energy per unit of energy "work" actually performed (such as increasing the thermal efficiencies of energy systems).

Reducing "work" traditionally has been thought to be correlated with lower economic growth and a lower standard of living; currently, new evidence is beginning to undermine this notion. In contrast, however, reducing "waste" does not threaten slow economic growth; generally, waste saving techniques are cost-effective in the sense that investments necessary to obtain them are paid back--often rapidly--by fuel expense reductions.

In 1971, about sixty percent of U. S. energy consumed was wasted (in the form of waste heat) rather than converted into work. The relationship between "waste" and "work" varies dramatically between different energy activities, as shown in Table 11, on the following page:

TABLE 11: 1971 U. S. ENERGY PRODUCTION, CONSUMPTION AND WASTE[12]

	Energy Consumed	Ultimate Work	Ultimate Waste	Percent Waste By Use
Intermediate Uses				
Electricity Generation	15.6Q	(5.5)[13]	10.1Q	64.7%
Final Uses				
Household/ Commercial	16.3	11.4	4.9	30.0
Transportation	17.2	2.6	14.6	84.9
Industry	19.6	11.8	7.8	39.8
Total	63.2Q	25.8Q	37.4Q	59.2%

Three policy options are available to produce more efficiency in energy: (1) influencing the allocation and consumption of energy through the price mechanism; (2) direct regulation, such as improved building codes; and (3) improving the information status of energy users, on the assumption that if consumers only knew the energy-cost associated with purchase alternatives, they would change their buying habits.

The current energy proposals include a study of the energy savings likely to result from higher gasoline prices. This makes sense because of the large inefficiency in the transportation sector and the acute environmental problems associated with auto emission. Equally important in both respects is electrical generation. Tentative results not only indicated that electrical consumption is sensitive to price changes, but also that forecast made by extrapolating prior demand into the future may be seriously in error unless prices decline radically.

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[12] Does not add, to avoid double-counting electrical inputs to the final use sectors.

[13] Science, "Conservation of Energy: The Potential for More Efficient Use", Vol. 178, No. 4065, (1081).

Table 12, below, indicates the growth of 1970 U. S. electric power consumption which could occur by the year 2000, at various multiples of 1970 electricity prices.

TABLE 12: SENSITIVITY OF ELECTRIC-CONSUMPTION TO PRICE[14]

2000 Price : 1970 Price	2000 KWH : 1970 KWH
2	1.3
1	2.0
0.5	8.0

According to these estimates, Federal Power Commission forecasts of doubling energy consumption every ten years (eight fold by 2000) would require a fifty percent long run electrical price decrease. The FPC estimates are based on a rigorous analytical forecasting model; but the model (like all econometric models) cannot account for all changes in prices, tastes, technology and the environment. Major changes in these factors could produce major changes in the estimates.

From a price standpoint, the current energy proposals consider restructuring electric rates. Various steps could be taken to price electricity on identical bases for all users and in a manner to better reflect increasing marginal supply costs.

Both auto and electricity pricing would be supplemented by other proposals. Auto efficiencies might be stimulated with auto excise taxes based on horsepower and/or weight; also, radial tires might be made mandatory.

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[14] Chapman, Tyrell, Mount; Science, 178, 703 (1972).

Electricity use might be better rationalized by discouraging promotional advertising. Both would be effected by a voluntary labeling program, which is also proposed. Finally, many of these outcomes may occur anyway as a result of other external factors. Radial tires, for example, may gain widespread acceptance because they are safer, not because they save energy.

The specific, long-run potential of these specific proposals is speculative. The general area of energy conservation, could ultimately reduce consumption by 25 percent.

A. Develop Technology to Tap Unconventional Energy Resources

Three proposals for tapping unconventional energy resources are included in the current energy proposals:

- Increased research and development on solar power.
- Increased funding of fusion research, aimed at producing a break-even demonstration by 1982.
- Increased geothermal research.

All three have significant implications for the energy supply only in the long term. Environmentally, however, they are important because they are clean systems.

V. MACRO-ENVIRONMENTAL IMPLICATIONS OF ENERGY GROWTH

U. S. energy consumption will almost double between 1970 and 1985, from 67 to over 120 quadrillion BTU's per year. The environmental damage resulting from this growth will depend on the fuels extraction and refining processes, transportation methods, and environmental protection measures involved. Nevertheless, even if every precaution is taken, a doubling of U. S. energy consumption in a fifteen-year period could potentially have dramatic environmental effects.

This section illustrates the pervasive effect of energy consumption growth on the environment during the next fifteen years. Two principal themes emerge:

- Energy's contribution to environmental damage is appreciable today and virtually certain to increase significantly.
- Energy systems affect the environment in many ways and at many diverse locations. Consequently, the environmental implications of doubling energy consumption are complex and far reaching.

1. THE PRODUCTION, TRANSPORTATION, AND CONSUMPTION OF ENERGY ARE MAJOR CAUSES OF ENVIRONMENTAL DAMAGE.

The environmental effects of energy span a broad range of air and water pollution, solid waste, and land use problems. Even at current levels of consumption, energy's contribution to environmental pollution is appreciable:

- Electric power plants account for over 80 percent of all thermal discharge from cooling water. Petroleum production and refining are major contributors to water pollution.
- Coal accounts for about 40 percent of all surface mining in the U. S. and has undermined over nine million acres of land by deep mining.
- On a tonnage basis, the bulk of the nation's air pollutants result from energy production and consumption.
- Energy distribution systems consume large areas of usable land--there are presently over one million miles of natural gas pipeline, 200,000 miles of oil pipelines, and 400,000 miles of electrical transmission lines. These facilities occupy over 33,000 square miles of land, about 1 percent of the total U. S. land.

These examples are by no means exhaustive. In fact, because of the magnitude and complexity of our energy systems, they contribute significantly to most existing environmental problems. These examples merely indicate the pervasive impact of energy on the environment.

2. THE GROWTH FORECAST FOR U. S. ENERGY REQUIREMENTS SUGGESTS THAT THE POTENTIAL ENVIRONMENTAL DAMAGE FROM ENERGY WILL INCREASE 50-100 PERCENT DURING THE NEXT FIFTEEN YEARS.

In order to illustrate the potential effects of meeting forecast energy consumption growth, this effort selects a set of energy supply assumptions which are reasonably pessimistic from an environmental standpoint.[1]

- Supply will be developed domestically, whenever technically and financially feasible. There will be a maximum effort to develop domestic energy resources.
- Environmental standards will not be increased dramatically, in order to encourage long-term development of abundant low sulfur coal and oil shale.
- Imports of foreign oil and gas will be minimized.
- Energy consumption will double from 68 quadrillion BTU's in 1970 to 125 quadrillion BTU's in 1985.

Table 1, at the end of this section, shows the consumption and supply amounts associated with these environmentally severe but not reasonably likely assumptions.

In brief, the key features of the forecasts are as follows:

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[1] These assumptions are similar to the assumptions used in Case #I of the National Petroleum Council's report on U. S. Energy Outlook. We have, therefore, used their supply forecasts under Case #I to illustrate the magnitude of the environmental effects.

- Domestic petroleum production increases 65 percent as a result of a maximum effort domestic exploitation program, including a high rate of exploratory drilling, accelerated OCS leasing, domestic refinery construction, and increased development of oil shale and conversion of coal to synthetic crude.
- Domestic gas production increases 57 percent as a result of significant price increases, increased federal leasing, nuclear stimulation, and the conversion of coal to synthetic gas.
- Nuclear power increases from 0.2 quadrillion BTU's (1 percent of the total U. S. consumption) in 1970 to 17 quadrillion BTU's (14 percent) in 1985.
- Direct-burning of coal increases 53 percent as a result of development of low sulfur Western coal and improved stack gas cleaning technologies to permit use of high sulfur Eastern coal.
- Oil imports in 1985 will equal 1970 imports; at times during the fifteen year period, however, import levels will be at double the 1970 level.
- Imports of natural gas will grow from 0.9 to 5.9 trillion cubic feet per year.

3. BY 1985 A MAXIMUM DOMESTIC OIL DEVELOPMENT PROGRAM WILL REQUIRE MAJOR INCREASES IN EXPLORATION, DRILLING, AND EXTRA EXTRACTION. MUCH OF THIS ACTIVITY WILL OCCUR IN AREAS WHICH ARE MORE PRONE TO ENVIRONMENTAL DAMAGE THAN EXISTING OIL-PRODUCING AREAS.

Tables 2 through 4 show (1) the estimated amount and type of oil drilling and exploration through 1985, (2) the likely regional allocation of drilling, and (3) the location of major oil discoveries during 1970-1985.

- The total number of oil wells drilled annually will double, from 20,000 in 1971 to 39,000 in 1985.
- The average well depth will increase 11 percent to 5200 feet in 1985.

- Offshore leasing will more than triple in fifteen years, from 673,000 acres per year to 2.3 million acres per year. During 1970-1985, a cumulative total of 21 million acres of OCS leasing will be required compared to 7 million acres of OCS leasing during the 15 years preceding 1970.

- Exploratory drilling will shift significantly to more environmentally sensitive areas (offshore and Alaska). In addition to a doubling in the total number of wells drilled annually, the percentage of total drilling allocated to offshore areas will grow from 2 percent in 1970 to 14 percent in 1985. Offshore drilling will be heaviest in the Gulf of Mexico (an increase from 2 to 9 percent of the total). Drilling will begin in the Atlantic and reach 2 percent of the total by 1985. Offshore drilling in California will grow to 3 percent of the total, and Alaska (both on and offshore) will account for 1.5 percent by 1985.

- The expected oil reserve discoveries -- and therefore the future drilling and production areas -- will be heavily concentrated in environmentally sensitive offshore and Alaskan areas. Out of a total of 119 billion barrels of oil-in-place discovered during 1970-85, a total of 77 billion barrels (65 percent) will be offshore or in Alaska.

A. As Domestic Petroleum Production Increases, There Will Be A Corresponding Growth in Oil Pipelines and Land Consumed by Distribution Facilities.

The growth in domestic oil piplines cannot be forecast accurately without numerous uncertain assumptions about the location and size of new discoveries, the regional demand growth patterns, oil imports, and the geographical shifts in oil consumption by electrical utilities caused by SIP requirements. Nevertheless, there is general agreement that oil pipelines will nearly double in fifteen years. An additional 200,000 miles of pipeline (consuming 2.8 million acres of land) will be constructed at a total cost of approximately $8 billion.

B. Domestic Refinery Capacity Will Increase About 80 Percent To Process The Increased Supply of Domestic and Imported Crude Petroleum.

Total petroleum supply is forecast to increase from 14.5 million barrels per day in 1970 to 19.1 million barrels per day in 1985. Oil imports are expected to climb from 3.4 MMB/D in 1970 to 7.2 MMB/D in 1975 and then decline to 3.6 MMB/D by 1985.

To the extent that imports consist of final products rather than crude, domestic refining capacity will not increase in direct proportion to the growth in the total oil supply. Under the maximum refining situation (NPC Case 3), domestic, refinery capacity would more than double by 1985. Table 5 shows U.S. refining capacity by PAD in 1972.

C. The Environmental Implications of A High Priority Domestic Oil Shale Development Program Would Be Significant.

Under nonemergency conditions, a maximum shale oil development program could produce approximately 750 MB/D in 1985.

Associated with the development would be:

- Eight mines, eight retorting plants, and four upgrading plants.
- Commitment of 11,000 acres of surface mining per year by 1985 and 1,500 acres per year for solid waste disposal.
- A requirement for 124,000 acre-feet of water per year by 1985, to meet mine and plant water requirements. The waste water will have a high saline content. Construction would have to begin immediately on the Montana-Wyoming aqueduct to transport water from the Bighorn and Yellowstone Rivers into the coal regions of Montana and Wyoming.

4. A MAXIMUM DOMESTIC NATURAL GAS DEVELOPMENT PROGRAM WILL REQUIRE EXTENSIVE INCREASES IN EXPLORATORY DRILLING AND PRODUCTION.

Table 6 shows the activity associated with a domestic supply maximizing effort for natural gas:

- The number of wells drilled will almost double from 3300 in 1970 to 6000 by 1985.
- The total footage drilled will more than double from 42 to 88 million feet per year.
- The average well depth will increase 28 percent to 7800 feet.

(A) Natural Gas Drilling Will Shift Toward More Offshore Activities, Although the Magnitude of the Change and the Potential Environmental Damage Will Be Less Than For Oil Production (See Table 7).

- OCS drilling will increase from 9 percent of the total in 1970 to 15 percent by 1985. Offshore drilling will be concentrated in the Gulf of Mexico (12 percent) and the Atlantic Ocean (2.5 percent).
- West Texas, the Western Gulf Basin, and the Midcontinent area will continue to account for almost two-thirds of all gas drilling.

(B) Nuclear Explosive Stimulation Will Be Used to Generate Natural Gas Reserves and Cumulative Production of 2.4 Trillion Cubic Feet by 1985 (See Table 8).

- A total of 670 productive wells are produced by nuclear stimulation during the fifteen year period.
- By 1985, the annual production from wells through nuclear stimulation will be over 150 TCF (2.5 percent of the total natural gas wells drilled in 1985).

(C) Gas Pipelines Will Grow Rapidly to Collect and Distribute the Increased Gas Production. Land Use Will Increase Commensurately (See Table 9).

- Total gas pipelines will increase 62 percent from 915,000 miles in 1970 to 1.5 million miles in 1985. The bulk of the increase will be for increased transmission and distribution.

- Land consumed by gas pipelines in 1985 will exceed 20 million acres (32,000 square miles). This is an area equivalent to the State of South Carolina and approximately 1 percent of the total U. S.

(D) A Maximum Gas Development Program Will Stimulate the Construction of Plants to Convert Coal to Pipeline Gas.

- Synthetic gas from coal will account for 2.5 trillion cubic feet by 1985.
- A total of 30 plants (located in New Mexico, Wyoming, Montana, and North Dakota) will be in operation by 1985.
- Approximately 232 million tons of coal (20-30 percent of total U. S. coal production) will be used for goal gasification by 1985. Over 90 percent of the coal used for gasification will be subbituminous (42 percent) and lignite (49 percent).

5. ELECTRICAL GENERATING CAPACITY WILL QUADRUPLE DURING THE NEXT TWENTY YEARS

As both a supplier and consumer of energy, the electrical utility sector will play a major role in the energy balance and its environmental effects will be far reaching. Many key environmental issues -- such as power plant siting, nuclear radiation, thermal discharge, and sulfur emissions from coal burning plants -- will be dominated by the scope and magnitude of electrical generation.

- Total U. S. generating capacity is forecast to grow from 340,000 megawatts in 1970 to 1.3 million megawatts in 1990, as shown in Table 11. Because of retirements, this growth will require more than 1 million megawatts of new plant construction.

- Nuclear plants will account for 46 percent of the new generating capacity. By 1990, there will be a total of 408 nuclear power units generating 475,000 megawatts (with an average size of 1,160 MW). Most of these will be new units constructed after 1970 (See Table 12).

- A total of 400 new generation sites will be needed by 1990; the bulk of those sites will be for conventional fossil steam (35 percent) and nuclear (41 percent) units. In addition to new sites, major additions will be required to existing generating sites (See Table 13).

- Land use for increased electricity production will be sizeable. The 400 new generating plants will require almost 80,000 acres, and 90,000 miles of new transmission lines will consume 1.8 million acres of land. Total land usage will exceed 2,900 square miles (See Table 14).

- Cooling water will increase many fold. Total cooling water now will increase from 2.3 million cubic feet per second in 1970 to 8.9 million cubic feet per second in 1990 (See Table 15).

6. DESPITE ENVIRONMENTAL AND FINANCIAL CONSTRAINTS, THE PRODUCTION OF U. S. COAL MAY NEARLY DOUBLE BY 1985.

As indicated by Table 15, total U. S. coal production will increase from less than 600 million tons per year in 1970 to 1000-1300 tons per year in 1985.

(A) As Coal Production Grows, There Will Be A Major Shift Toward Increased Surface Mining. The Environmental Effects Will Be Dramatic.

- Table 15 shows that surface mined coal will grow from approximately one-third of the total in 1970 to about half in 1985.

- The principal increase in strip-mining will occur in the western states where there are large deposits of relatively low-sulfur coal. Western surface mining will grow from less than 100 million tons/year to 300/400 million tons per year. Eastern strip-mining will nearly double during the period.

- Although declining in relative importance, the absolute amount of deep mined coal is forecast to increase from about 400 million tons in 1970 to 500-600 million tons in 1975.

(B) The Environmental Implications of Increased Coal Production Raise Serious Questions About the Need for Increased Mining Regulations (See Table 16).

- Water pollution, in terms of suspended solids, amino acids, and dissolved solids will almost double during the next fifteen years.
- Over one million additional acres of land will be strip-mined by 1985, almost equal to the total amount of coal surface mined to date.
- Large quantities of solid waste overburden will be created which will have to be disposed of effectively.
- Increased water requirements will strain existing systems.

TABLE 1: PROJECTED ENERGY CONSUMPTION
NPC CASE I -- 1970-1985

(10^{12} BTUs/Year)

	Actual 1970		Projected 1985		1970/
	BTU's	%Total	BTU's	%Total	1985
Domestic Supplies					
Oil					
-Conventional	21,048	31	31,689	26	151
-Shale syncrude	0	0	1,478	1	NA
-Coal syncrude	0	0	1,489	1	NA
Subtotal oil	21,048	31	34,656	28	165
Gas					
-Natural	22,388	33	31,604	25	141
-Nuclear stimulation	0	0	1,341	1	NA
-Coal syngas	0	0	2,269	2	NA
Subtotal gas	22,388	33	35,214	28	157
Hydropower	2,677	4	3,320	3	124
Geothermal	7	-	1,395	1	NA
Nuclear	240	1	16,910	14	NA
Coal	13,062	19	20,000	15	153
Total Domestic Supply	59,422	88	111,495	89	187
Imported Supplies					
Oil	7,455	11	7,547	6	101
Gas	950	1	5,900	5	621
Total Imported Supply	8,405	12	13,447	11	160
Total U. S. Consumption	67,827	100	124,942	100	184

Source: U. S. Energy Outlook; NPC; 1972.

TABLE 2: OIL DRILLING & EXPLORATION

NPC CASE #1

Year	Total Annual Wells Drilled (000's)	Average Well Depth (feet)	Offshore * Federal Leases Acres/Year (000's)
1971	4700	673	20
1975	4800	1101	26
1980	5000	1663	35
1985	5200	2263	39

*A cumulative total of 21 million acres OCS required during 15-year period, compared to 7 million acres OCS during 15 years preceeding 1970.

TABLE 3: EXPLORATORY DRILLING
PROJECTED REGIONAL ALLOCATION

Region	Exploratory Oil Drilling			
	1970 Actual		1985 Projected	
	% Total	Feet (mil)	% Total	(Feet (mil)
Offshore				
- California	0.5		3.0	
- Gulf	2.1		9.0	
- Atlantic	0.0		2.0	
Total offshore	2.6	1	14.0	9
Alaska *	0.1		1.5	
Lower 48 Onshore				
- California	4.2		4.0	
- Western Rocky Mtns.	6.0		5.1	
- Eastern Rocky Mtns.	28.1		24.6	
- West Texas	14.4		12.5	
- Gulf Coast Area	27.8		19.6	
- Mid-Continent	14.0		8.2	
- Illinois Basin, Michigan and Appalachians	2.3		6.5	
- Atlantic Coast Area	0.5		4.0	
Total Lower 48	97.3	24	84.5	56
Total United States	100.0	25	100.0	65

Source: U.S. Energy Outlook: An Interim Report, Oil Demand Task Force, 1972.

* Excludes North Slope

TABLE 4: OIL-IN-PLACE (OIP) DISCOVERED

(Billion Barrels)

Region	OIP Discovered to 1/1/71	OIP Discovered 1971-85	Ultimate Discoverable OIP	% Ultimate OIP Discovered 1971	% Ultimate OIP Discovered 1985
Offshore					
- Pacific Ocean	1.9	20.2	49.6	4	45
- Gulf	11.5	13.6	38.6	30	65
- Atlantic	0.0	2.2	14.4	0	15
Total Offshore	13.4	36.0	102.6	13	48
Alaska					
- Southern Alaska including offshore	2.9	11.6	26.0	11	56
- North Slope onshore	24.0	29.0	72.1	33	74
- North Slope offshore	0.0	0.0	47.9	0	0
Total Alaska	26.9	40.6	146.0	18	46
Lower 48 Onshore					
- Pacific Coast	80.0	2.6	101.9	79	81
- Western Rocky Mtns.	5.8	1.6	43.6	13	17
- Eastern Rocky Mtns.	23.9	7.9	52.4	46	60
- West Texas Area	106.4	8.7	151.6	70	76
- Western Gulf Coast Basin	79.7	11.8	109.0	73	84
- Mid-Continent	58.4	3.9	63.0	93	99
- Michigan Eastern Interior and Appalachians	30.5	4.9	36.5	84	97
- Atlantic Coast	0.2	1.0	3.8	5	32
Total Lower 48	384.9	42.4	561.8	69	76
Total United States	425.2	119.0	810.4	52	67

Source: U.S. Energy Outlook, NPC, 1972

TABLE 5: U. S. REFINERY CAPACITY

PAD District	Capacity MMB/D	Number Plants
I	1.6	29
II	3.5	70
III	5.4	78
IV	0.4	27
V	2.2	43
Total	13.1	247

Source: OGJ; March 27, 1972; p. 136.

TABLE 6 NATURAL GAS DRILLING & EXPLORATION[1]

Year	Footage Drilled Million Feet/Year	Annual Wells 000	Average Well Depth (feet)
1970	42	3200	6100
1975	52	4000	6800
1980	75	5400	7000
1985	88	6000	7800

[1] Excludes Alaska

TABLE 7: GAS DRILLING REGIONAL ALLOCATION[1/]

Region	Percent Total Drilling 1968-70 Average	 1985 Projected
Offshore		
- Pacific Ocean	0.01	0.30
- Gulf of Mexico	9.11	11.80
- Atlantic Ocean	0.00	2.50
Total Offshore	9.12	14.60
Onshore		
- Pacific	1.97	2.00
- Western Rocky Mtns.	3.93	5.10
- Eastern Rocky Mtns.	3.72	6.20
- West Texas	8.82	10.60
- Western Gulf Basin	40.46	31.20
- Mid-Continent	16.95	15.80
- Illinois & Michigan	0.88	0.70
- Appalachians	13.90	12.80
- Atlantic Coast	0.03	1.00
Total Onshore	90.66	85.40
Total United States	100.00	100.00

Source: NPC

[1/] Excluding Alaska, which accounted for 0.22% of 1968-70 average.

TABLE 8: NUCLEAR EXPLOSIVE STIMUATION

	NATURAL GAS PRODUCTION		
Year	Annual Production TCF/Year	Cumulative Wells	Annual Wells Completed
1980	0.2	NA	NA
1985	1.3	676	160

Source: U. S. Energy Outlook; NPC; 1972.

TABLE 9: GAS PIPELINE DEVELOPMENT

	Miles of Pipe (000's)				1985/
Type of Pipeline	1970	1975	1980	1985	1970
Field and Gathering	66.6	77.2	91.2	112.2	168%
Transmission	252.6	293.2	346.3	426.1	169%
Distribution	595.7	698.4	813.3	943.9	158%
Total	914.9	1068.8	1250.8	1482.2	162%

Source: Gas Utility Projections 1971-1985: American Gas Association, 1971.

TABLE 10: COAL GASIFICATION PRODUCTION - 1985

Type of Fuel	Number of Plants	Million Tons/ Year	Percent of Total
Bituminous Coal	4	21	9
Sub-bituminous Coal	13	47	42
Lignite	13	114	49
Total	30	232	100

Source: U. S. Energy Outlook.

TABLE 11: GENERATING CAPACITY BY TYPES OF PRIME MOVER, PEAK DEMANDS AND RESERVES

Capacity	1970[1]		1980		1990	
	MW	Percent	MW	Percent	MW	Percent
Conventional Hydro	51,600	15.2	68,000	10.4	82,000	6.5
Pumped Storage Hydro	3,600	1.1	27,000	4.0	70,000	5.6
IC and Gas Turbines	19,200	5.7	40,000	6.0	75,000	5.9
Fossil Steam	259,100	76.1	390,000	58.6	558,000	44.3
Nuclear	6,500	1.9	140,000	21.0	475,000	37.7
Total	340,000	100.0	665,000	100.0	1,260,000	100.0
Peak Demand	275,000		555,000		1,050,000	
Indicated Reserves	64,300		110,000		210,000	
Reserves in Percent of Peak	23		20		20	

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[1] Year-end capacity is shown, some of which was installed after the date of peak demand. Therefore, actual reserves were somewhat less than indicated.

Source: 1970 National Power Survey; FPC, 1971.

TABLE 12: NUCLEAR CAPACITY BY UNIT SIZES, 1980 AND 1990

	1980			1990		
Unit Size MW	Capacity MW	No. of Units	Avg. Size MW	Capacity MW	No. of Units	Avg. Size MW
600 and less	13,000	34	380	18,000	43	420
601 to 1,200	93,000	101	920	223,000	227	980
1,201 to 1,800	34,000	23	1,480	139,000	95	1,460
1,801 to 2,400				66,000	32	2,060
2,401 to 3,000				29,000	11	2,640
U. S. Total	140,000	158	890	475,000	408	1,160

Source: 1970 National Power Survey.

TABLE 13: NEW GENERATING PLANT SITES REQUIRED BY TYPES OF PLANT 1971 TO 1990

	Number of Plant Sites		
	1971-1980	1981-1990	1971-1990
Conventional hydro (100 MW and above)	15	25	40
Pumped storage hydro (300 MW and above)	20	35	55
Fossil steam (500 MW and above)	80	60	140
Nuclear (500 MW and above)	70	90	160
Total	185	210	395

Source: 1970 National Power Survey.

TABLE 14: ELECTRICAL LAND USE

	Additions 1970-90	Approximate Land Required (acres)	Additional Total Land Required	
			Acres	Sq. Miles
New Generating Plants	395	200	79,000	123
New Transmission Lines (miles of 230 Kilovolt and higher lines)	90,000	20	1,800,000	2,813

TABLE 15: ELECTRICAL WATER DISCHARGE

	Actual 1970	Estimated	
		1980	1990
Total Electric Consumption (million megawatt-hours)	1530	2775-3210	5026-6325
Total Cooling Water Requirements (million cubic feet per second)	2.3	4.2-4.8	7.5-9.5
Percent Increase Over 1970		83-108%	226-313%

TABLE 16: ESTIMATED U. S. COAL PRODUCTION
(MMT/Yr)

Type Coal	1975	1980	1985
Eastern Region			
Deep mined	334-352	403-467	431-546
Surface mined	71-81	105-154	114-210
Central Region			
Deep mined	29-35	51	57
Surface mined	50-61	87	114
Western Region			
Deep mined	10	11	13
Surface mined	97	116-217	243-414
Total US			
Deep mined	373-397	465-524	501-616
Surface mined	218-239	308-458	471-738
Total	591-636	773-987	972-1354

Note: The ranges shown in these estimates bracket the NPC Case #1 forecast of 1093 MMT/year in 1985.

Source: EPA Baseline Study of Supply and Demand; prepared by Cheryl Wasserman; draft November 7, 1972.

TABLE 17: ENVIRONMENTAL EFFECTS OF FORECAST COAL PRODUCTION[2]

	Eastern Coal		Western/Central	
	Strip	Deep	Strip	Deep
1985 Annual Rate				
Tons of Coal Produced (mm)	162	488	443	70
Water Pollution				
• Suspended solids (mm tons)[1]	194	-	531	-
• Dissolved solids (tons 000's)	636	26000	1741	
• Acids (H_2SO_4) (tons)	721		1971	
Solid Waste				
• Overburden (mm tons)	188	20	203	
Land Use				
• Acres disturbed (000)	50	150	136	
Occupational Health				
• Deaths	20	NA	53	
• Injuries	900	NA	2463	
1975-1985 Cumulative				
Tons of Coal (mm)	1190	4150	2980	
Water Pollution				
• Suspended solids[2] (mm tons)	1428	-	3576	-
• Dissolved solids (tons 000's)	4676		11711	
• Acids (H_2SO_4) (tons)	5295		13261	
Solid Waste				
• Overburden (mm/t)	1380		1370	

(Table Continued)

(continued)

TABLE 17: ENVIRONMENTAL EFFECTS OF FORECAST COAL PRODUCTION[2/]

	Eastern Coal		Western/Central	
	Strip	Deep	Strip	Deep
Land Use				
• Acres disturbed (000's)	367		918	
Occupational Health				
• Deaths	143	NA	357	NA
• Injuries	6,616	NA	16,568	NA

1/ Accumulation over five-year period.

2/ Based on mid-points of EPA estimated ranges and environmental pollution factors in Battelle Memorial Institute Study.

VI. ENERGY-ENVIRONMENTAL CONCLUSIONS AND NEXT STEPS

Preceding sections have analyzed the energy-environmental problem, the future energy supply-consumption outlook, the macroenvironmental implications of energy in 1985, and the Administration's current energy proposals. This section summarizes the major conclusions of this analysis and proposes key analytical areas which need further work. Our analysis of the energy-environmental problem and the proposed policy changes suggest numerous issues and conclusions which could affect EPA and the environment. All or most of these issues may be important at some future date. However, our conclusions and recommended next steps focus only on those issues we consider to be of paramount importance to EPA--we believe the bulk of the environmental impacts from energy growth will be concentrated in a limited number of key areas.

1. ENERGY CONSUMPTION, AND ITS POTENTIAL IMPACT ON THE ENVIRONMENT IS GOING TO INCREASE RAPIDLY THROUGH 1985, AND POSSIBLY BEYOND.

Total energy consumption is going to increase 3.5 to 4.5 percent per year through 1985. In spite of advances in future environmental controls, the impact of this growth on the environment will be appreciable.

At some point, new technology and the increasing shortage of fossil fuels of all types may enable energy systems to use fuels which are almost completely clean relative to conventional fossil fuels. For the foreseeable future, however, all energy systems likely to be of any major significance will pollute.

A. If Domestic Resources are used to Support this Growth, Environmental Damage May Increase Faster than the Energy Growth Rate Itself.

Current energy policymaking implies a strategy of domestic self-sufficiency based on a predominantly fossil-fuel energy economy through the balance of this century.

(1) The Amount and Timing of the Environmental Impact of this Domestic Fossil Fuel Strategy Hinges on the Success in Finding New Petroleum and Natural Gas.

At the point of consumption, petroleum and natural gas are the cleanest fossil fuels. However, as domestic petroleum and natural production increases, not only will the level of new field exploration and development increase, but it will encroach successively further into environmentally-marginal areas offshore and in Alaska. In addition, logistical facilities (pipelines) and refining and its associated petroleum-consuming industry will increase commensurately. These impacts, however, appear to be less than the impacts associated with the production of an equivalent amount of other fossil fuels.

(2) Unfortunately, our Most Abundant Fossil Fuel Resources Embody the Greatest Environmental Damage; If Petroleum and Natural Gas Reserves Shrink, the Dependence on Environmentally More Damaging Synthetic Petroleum and Gas (From Coal and Oil Shale) Energy Systems will Increase.

Because of their abundance, synthetic gas and crude from coal and oil shale will probably become significant sources of energy at some future point. Both will entail mining impacts on land and water pollution and water resource problems. Much of the coal will come from Western states -- which are relatively unspoiled and where water diversion will be required ultimately to support a large "synthetic" industry.

(3) There is a Large Environmental Tradeoff Between Water, Air, and Land Pollution with Respect to the Choice Between Petroleum/Natural Gas and Coal.

The treatment of environmental problems related to mining, particularly surface mining, may determine the outcome of other environmental problems. Specifically, pressure for "clean fuels" for stationary sources promotes mining of Western low-sulfur coal and could promote coal and oil shale extraction related to a synthetics industry. Conversely, environmentally protective mining restrictions can have two adverse effects. First, it can reduce the availability of low-sulfur coal; thereby, forcing a less rigorous air pollution program. Alternatively, it can shift Eastern mining to Western areas (by surface mining slope restrictions) with potentially greater overall environmental impacts.

(4) The Environmental Effects of Increased Energy Usage and Increased Usage of Coal Can Be Moderated by Prudent Siting of Energy Producing and Using Activities.

Just as alternative energy systems imply different rates of pollution, different sites for the activities associated with these systems imply different environmental effects. For example, offshore drilling in Pacific Coast areas appears environmentally inferior to Gulf Coast drilling. Similarly, increased refinery activity in Gulf areas appears environmentally preferrable to a similar increase in East Coast areas. Finally, site selection for central power plants appears able to vary the environmental impact substantially.

(5) Nobody is Adequately Prepared to Affect the Environmental Outcome of Future Energy Trends; The Lack of Siting Criteria, The Lagging Legal Authority and Technical Knowledge With Respect to the Water and Land Consequences of Vigorous Air Protection, and the Lack of a Systematic Methodology to Tradeoff Competing Energy Systems and Environmental Protection Needs Are Serious Handicaps.

Environmental protection competes with other national objectives and powerful constituencies, particularly with regard to energy. Within this framework, the general notion is that EPA should "internalize environmental costs" and, back up by "not-to-exceed" environmental standards, let the market adjust energy activities accordingly. In this situation, environmental protection depends heavily on EPA's ability to develop and enforce standards in all of the key environmental areas affected by energy systems. Existing EPA standards and legal authorities are inadequate in many areas likely to be affected by the growth in energy consumption.

B. The Nature of the Energy Crisis Depends on Whose Consumption and Supply Forecast You Believe and Whether or not you Believe that the Growth Rate Can Be Dampened Through Conservation Measures.

Current energy policymaking has crisis overtones. But the urgency of the crisis is highly sensitive to small changes in forecast energy supply and consumption.

(1) The Energy Crisis is Prompted by a Short-Term Clean Fuels Deficit (A Transitional Problem) and the Spectre of Ever-Increasing Petroleum Imports (The Magnitude of which is Subject of Considerable Forecasting Uncertainty).

Some current proposals affect the short-term, but most would not be effective until 1980-85. To the extent that greater than ten-year leadtimes are required, this is appropriate. Otherwise, long-term commitments may be made to environmentally-marginal energy activities in the heat of a crisis caused by a short-term clean fuels shortage and petroleum imports bulge.

(2) The Crisis Policymaking is Based on Energy Forecasts Which are of Mixed Quality.

Forecasting in the energy areas is an unscientific and highly controversial business. Generally, forecasts have three biases:

- They extrapolate historical consumption trends.
- They use absolutely conservative fuel resource reserve information.
- They ignore price and, in general, assume the status quo.

The urgency of making policy with respect to many of the current proposals depends on the urgency assigned to these forecasts. Generally, the validity of the forecasts is subject to question.

(3) Initial EPA Analyses Suggest That Energy Conservation Is Possible, Without Slower Economic Growth.

Ultimately, considerable energy potentially can be saved by reducing the "waste" now inherent in energy systems. Generally, the reduction of waste is cost-effective; the higher initial investment costs necessary to reduce waste are paid back rapidly in fuel cost savings. Because energy savings cumulate not only non-renewable resources are permanently preserved and the rate at which increasingly marginal environmental energy sources must be tapped is reduced. Energy conservation also buys time to protect environmentally marginal areas and develop cleaner energy systems.

2. FURTHER EPA ANALYSIS OF THE ENERGY-ENVIRONMENT PROBLEM SHOULD CONCENTRATE ON MINIMIZING THE ADVERSE ENVIRONMENTAL IMPACTS OF AN ENERGY STRATEGY AIMED AT DOMESTIC SELF-SUFFICIENCY.

The conclusions discussed above suggest that future EPA analysis of the energy problem should meet one or both of the following criteria:

- An attempt to anticipate and mitigate the adverse environmental implications of the domestic energy strategy.
- Improvement of EPA's knowledge of the fundamental assumptions driving that strategy.

A. The Most Immediately Pressing Problem Facing EPA Is The Projected Short-Run Clean Fuels Deficit

Implementation of the Clean Air Act will increase the clean fuel shortage by reducing the supplies of acceptable fuels for stationary sources; this will probably stimulate further price increases for petroleum and natural gas.

Imports will increase significantly at least through 1977, and depending primarily on the response of the electric power companies, possibly beyond.

Rising fuel prices and imports, combined with selective shortages, will increase pressures to make selective or across-the-board adjustments in the State Implementation Plans.

In addition, EPA analysis indicates the clean fuels deficit is only a problem in the short-run; there are many ways to offset the shortage after 1975-77. However, the clean fuels shortage could become a long-term problem unless many factors (few if any of which are under EPA control) simultaneously change to relieve the deficit. For example, EPA expects a third of the deficit to be covered by additional low-sulfur coal; but low-sulfur coal depends on a decision by the electric utilities to rely on coal, a long-term contract, and a major investment committment by the coal companies. Uncertainties about future fuels prices, import restrictions, and environmental constraints could prevent the development of additional low-sulfur coal. Likewise, stack gas cleaning is forecast to cover 35 percent of the deficit by 1977; but this depends on large and potentially risky capital investment decisions by the electric utilities.

All aspects of the clean fuels shortage warrant further analysis. However, two critical aspects of the problem should provide the focus for further consideration:

- SIP Modifications --- a detailed review of potential changes in the SIP's, including:
    - -- analysis by major geographical location
    - -- degree and nature of the problem
    - -- examination of alternative solutions
    - -- forecast estimated duration of changes
- Long-term Solutions --- EPA should begin now to ensure that steps required to relieve the clean fuels deficit after 1975 are begun now. Many of these steps are outside EPA control and can be of influence only indirectly. Nevertheless, the key next steps include:
    - -- development of additional low-sulfur coal resources and long-term contracts with the electric utilities.

- development and application of effective stack gas cleaning systems
- selective SIP modifications
- availability of adequate petroleum and natural gas imports
- development of necessary economic or technological incentives

(B) Mining Regulation Is The Second Key Problem Area

The long-run domestic self-sufficiency strategy, combined with the clean fuels problem, will increase the need for environmental regulation of mining. Although all aspects of deep and surface mining will be important, four areas emerge as crucial:

- the feasibility of reclaiming strip mined areas and thus internalizing environmental costs
- the likely effect of surface mine prohibitions and slope restrictions on east and west coal production and the clean fuel deficit
- the development of large-scale western water resources
- the economic and environmental implications of large-scale oil share development.

(C) EPA Energy Siting Policies Will Have Complex and Pervasive Effects on the Environment

The location of energy facilities affects the environment in two ways; the facility itself causes pollution and it attracts other energy consumers or processors to concentrate in adjacent areas, thereby concentrating the pollution. EPA siting policies should focus on two key issues:

- Electric Power Plant Siting --- there will be large increases in the number and size of electric generating facilities by 1985. Siting policies must be developed for both nuclear and conventional fossil fuel facilities.

- Super Port/Refinery Problem -- oil imports will increase appreciably by 1980 under any strategy. There is general agreement that these imports will be delivered via superports and tankers. The location of these ports will dramatically affect the environment by concentrating refineries, petrochemical plants, pipelines and logistical facilities, and industrial energy consumers in the adjacent areas.

D. Proposals to Lower Environmental Standards Are Frequently Justified On The Bases Of The "Energy Crisis". The Crisis, However, Exists Primarily As A Function Of Many Uncertain And Controversial Forecasts Of Energy Consumption And Supply. EPA Should Increase Its Understanding Of These Forecasts, And Their Sensitivities Of Different Assumptions In The Following Key Areas:

- Forecast reserves of petroleum and natural gas.
- The magnitude and importance of energy balance of payments deficits.
- Price elasticities for energy overall, and particularly in the key transportation and electric utility sectors.
- Supply elasticities between synthetic and conventional fuels.

E. Finally, Considerable Benefits May Be Possible Through Continued Work on The Energy Conservation Issue.

- Significant energy conversion losses due to the forecast shift to electricity and away from direct consumption.
- The potential demand reduction effects from increased fuel prices or lower Federal subsidies.
- The need for a time-phased conservation strategy by consuming sector.
- Incentives, other than price, to encourage energy conservation.